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POLYPHASE WORK.

IT has been a matter of comment among foreign engineers that so little has been done in this branch of electrical engineering in Great Britain.

In America, and on the Continent of Europe, polyphase motors and systems of transmission of electrical energy to a distance have interested and engaged the closest attention of the foremost electrical engineers; and the subject has rapidly assumed a most important commercial position, as well as a highly scientific development, so that polyphase principles are likely to largely influence the future lines along which electrical engineering progress is to run.

At the outset the alternating current system commenced with transformers in each consumer's house; the energy was transmitted from a centre to these transformers at high pressure, and from the transformers the energy was distributed at low pressure throughout the house. Now, however, the practice is to lay down two sets of mains, one a high pressure transmission set, carrying the energy from the central station to sub-stations where it is transformed, while the other set of distribution mains distribute the energy at low pressure within a certain distance from the sub-station.

The primary mains are for transmission, the secondary mains for distribution. There is not, we are afraid, sufficient importance attached to the difference between the two. Transmission lines must be worked at high pressure, and by a current easily and efficiently transformed. Distribution lines must be worked at low pressure by current derived from the transmission current or primary feeders.

Now the primary high pressure current sent along the transmission feeders to the sub-stations may be, and in this country always is, a single-phase alternating current, and this can be easily and efficiently transformed to a single-phase low pressure current only. It cannot easily or efficiently be transformed into a polyphase or a continuous current, and this is where polyphase principles come in, in the electrical transmission and distribution of energy in towns.

If we adopt polyphase currents for the transmission of the energy, we find that at the sub-stations we can, with ease and high efficiency, convert it into low pressure continuous current, low pressure single-phase alternating current, or low pressure polyphase currents to supply the distribution mains, and thus we have a choice of any of the three currents for distribution, and may supply any one, or all three, from any sub-station.

It may truly be said that in the present state of electrical engineering only a supply for lighting is in demand, and that, for this purpose, low pressure single-phase current meets the demand entirely. Quite so; but if with equal economy and the same plant, and no additional trouble, we

can transmit our energy by polyphase currents and thereby secure the advantages of being able to supply any other kind of current from the sub-stations, why should not polyphase transmission in every case be adopted, especially by municipal bodies, who must look forward to the continual extension of their electric systems.

It is all very well for a company with a district, limited in area allotted to them for lighting, to lay down a system of three-wire low pressure mains, or a system of single-phase transmission mains, and a few sub-stations, but for a public body to do likewise is doubtful policy; they must look to the future, and adopt the system which offers them the greatest facility in obtaining, from a transmission current of high pressure, the various forms of electric current used in practice. The only transmission currents for such purposes are polyphase.

On these grounds the two-phase method was adopted for the transmission of the energy from Niagara Falls. With this it is possible to supply distribution systems with either or all of the other kinds of current from sub-stations, and for the same reasons the transmission of electrical energy throughout towns ought to be carried out by polyphase currents. The distribution may be effected, then, by single-phase, polyphase, or continuous current, just as we please.

It has already been pointed out in the Electrical Review that polyphase currents are preferable for electrical installations in mines and on board steamships, if for no other reason than the one that commutatorless electromotors may be applied to do the work of steam and hydraulic engines now used in these places.

Polyphase motors alone fulfil the requirements in a mining motor; there can be no sparking; it requires absolutely no attention except lubrication, and it can be started, stopped, or reversed by a switch at a distance. The polyphase currents can be transmitted at high pressure and transformed either for lighting or power purposes anywhere in or about a mine.

On board steamships many small, wasteful, troublesome steam engines, are now used for various purposes, such as ventilating, pumping, refrigerating, operating winches, ash hoists, &c. All of these could, with ease and with profit, be replaced by electromotors without brushes and commutators. All that is necessary is to distribute the electrical energy in two-phase currents; light and power may then be obtained anywhere on the ship with equal ease.

If the electromotor had not hitherto had a commutator and brushes continually requiring attention, it is quite probable that it would have been adopted to a much greater extent in mining and marine operations.

It has been hinted that the fear of litigation on the patents question has deterred engineers from recommending the polyphase system and the polyphase motor. This is a reflection on our engineers; it implies that they would adopt them freely if they could do so free of cost, and that they would rather stay their introduction than pay royalties.

Whatever is the cause of the apathy displayed towards new developments in this country, we do not know; it is a curious fact, however, that a long time elapses between the introduction of really good inventions and their adoption. This is the case with polyphase work; its advocates are enthusiastic and make great claims for it, have spent time, money, and brains, on perfecting it, and yet the ordinary engineer jogs along the beaten path quite oblivious to all their efforts. Another case in point was that of the transformer; for years up till 1886 it was advocated by enthusiastic inventors, only to meet with scorn or pitying smiles.

We believe there is a good deal of truth in the claims of polyphase advocates, and that they form a subject worthy of close study by every engineer. Like all really beneficial inventions, it promises to widen the field of usefulness and application of electrical science and appliances generally.

The polyphase motor has received only small attention here, and that by only two or three engineers. In inquiring into the nature of these motors, it may be as well to point out that there are two distinct classes, rotary current motors on the Ferraris-Tesla system with rotating poles, and induction motors with no rotary poles on the Kennedy and Stanley system. In looking up the patents question on polyphase motors, it is well to distinguish carefully between the two types. In a series of articles shortly to appear in our columns, a simple explanation of the fundamental actions of these induction and rotary polar motors will be attempted, with a view to distinguish between the different types, and to place a simple conception of their construction and action before the student.

A commutatorless single-phase motor has been fully developed by the Oerlikon people, but we believe it requires a commutating device to start it. We are not aware of any tests made with it in this country, but if any are available, it would be interesting to compare them with tests of polyphase motors.

The single-phase induction motors have one advantage over synchronous motors, in that they are much easier started, not requiring to be run up to synchronism. All they demand is a start up to about one-fourth of the normal speed.

The Behaviour of Alloys in a Voltaic Circuit.

Mr. A. P. Laurie has made this subject his own in virtue of several important papers which he has contributed to the *Philosophical Magazine* and read before the Chemical Society. He is at present engaged in examining into the electromotive force of all the alloys described in Matthiesen's classical thesis on "Electric Conductivity" (*Phil. Mag.*, 1860, cl., p. 161), and, in the meantime, has observed certain isolated facts which he has recently laid before the Chemical Society. It appears that he has discovered another group of alloys which neither give at once the E.M.F. of the more positive metal when placed in a voltaic circuit, nor show any abrupt discontinuity in the curve of E.M F. on passing over a particular alloy. In these alloys the E.M.F. rises rapidly, and a continuous curve to the value of the more positive metal is obtained on passing through alloys containing more and more of the more positive metal in their mixture. If, for instance, antimony and lead be taken and the E.M.F. of antimony be measured against lead, it is found that the latter metal is the more positive, and by testing antimony against alloys of antimony containing increasing quantities of lead, the E.M.F. is found to rise gradually in a continuous curve. The E.M.F. was taken in a solution of common salt. The other facts referred to by Mr. Laurie were interesting, chiefly from a more strictly chemical point of view, and need not be alluded to here. We shall look forward with some degree of anticipation to Mr. Laurie's promised paper, in which he proposes to review and extend Matthiesen's results as set forth in the 1860 paper.

NAVAL DYNAMO MACHINERY.

(*Continued from page* 99.)

IV.—The Standard Switchboard.

The specifications for the system of switchboard connections have been growing more complicated from year to year. For one of the latest vessels equipped they read: "The design to be such that the dynamos may be run either singly or in multiple on the incandescent circuits, either singly or in multiple on the arc-light circuits, and either singly or in multiple on the arc and incandescent circuits connected in parallel." A standard switchboard has consequently been devised to meet these specifications without taking up valuable space.

Whatever the number of circuits or dynamos installed, the system is the same, so that an engineer familiar with it can operate the switchboard at first sight. Suppose the switchboard to be designed for three dynamos and 18 branch circuits: the board has on each of its edges a vertical bus bar fitted with fuse clamps and terminals at the lower ends, the two bars being connected by a cable on the back of the board. The bus bar thus formed is common to all the dynamos, and in practice is connected to the positive terminals. Inside of this bar are the fuses on the positive ends of the branch circuits. On each side of the centre of the board there is a set of vertical bars, each set containing as many bars as there are dynamos. The similarly situated bars of each set, counting from the left as number one, are connected together by a cable on the back of the board, forming the negative bus bar of the same dynamo. Between the two sets of negative bars are the negative branch circuit fuses.

One-half of the branch circuits are placed on each side of the vertical centre line. The positive terminal of each is in the clip near the common bus bar in which the switch engages. The negative end of the circuit is in the socket, in which fits the shifting plug switch, near the centre of the board. One of these sockets is placed between each two of the negative bus bars. The plug switch has two small bosses on each side, which serve to clamp it in the socket in the open position at right angles to the face of the board. By withdrawing the plug slightly the bosses are disengaged, and the switch may then be thrown to right or left, connecting its circuit to either one of the dynamo bus bars between which it is placed. In a board designed for three or four dynamos the plug switch may be shifted from one socket to another, so as to be placed in position to connect its circuit to any bus bars.

The switches for converting the dynamos in parallel are at the bottom of the board. They are double pole, the upper half connecting the negative bus bars, while the lower half connects the two equalising bars. The board for two dynamos has only one multiple switch, but those for three or four have a switch for each dynamo. In the latter case, the upper half of the switch connects the negative bus bar of its dynamo to a common negative bus bar, while the lower connects the equalising bar of the same dynamo to a common equaliser. It is then necessary to close two switches to connect two dynamos in multiple, the connection not being complete until the last switch is closed. When two or more dynamos are operating singly, the multiple switches are open, and hard rubber guards are placed on the clips to prevent any accidental closing.

As one pole of each dynamo is connected to a common bus bar, it can be entirely cut out of circuit only by a double pole switch on the head-board of the dynamo. This switch is therefore a necessity when the standard switchboard is used, and should always be open when the dynamo is not in operation. All connections are made on the back of the board. Each conductor is soldered to a conical copper plug, the end of which has a screw thread tapped in it, and fits into a corresponding conical socket in the bus bar or fuse terminal, being secured in place by a screw inserted from the front of the board. When this is screwed up it makes a good reliable contact.

The design of the switchboard is very simple. All vertical lines are dynamo circuits, all horizontal ones branch circuits, the plug switches being at the intersections.

In the arrangement for switch and instrument boards, the left hand instrument board carries at the top a ground detector fitted with a multi-throw switch, having as many contacts as there are dynamos. By connecting this with one of the negative bus bars, starting the corresponding dynamo and throwing any plug switches on the same bus bar, each and all branch circuits can be tested for grounds, or an existing ground can be speedily localised. On the middle of the board is a vertical reading Weston voltmeter. One of its terminals is connected to the common bus bar, the other to a multi-throw switch, by which it can be put in connection with any one of the negative bus bars. By moving this switch the potential of any one of the dynamos may be measured and the polarity also tested, the voltmeter needle showing the direction of the current in the instrument. This voltmeter is always kept in circuit, and can be read from a distance. The lower voltmeter is connected so as to give the difference of potential at the terminals of the search lights, having a multi-throw switch with as many contacts as there are projectors. It is identical with the other voltmeter, and is in reserve in case of accident.

Underneath the switchboard are the shunt field rheostats, the left hand being in circuit of the dynamo, connected to the left hand bus bar, which in turn is connected to the left terminal of the voltmeter multi-throw switch. The instrument board on the right of the switchboard carries the ammeters, one being in circuit of each dynamo. The same sequence is always followed from left to right on the negative bus bars, voltmeter terminals, and shunt field rheostats, and from top to bottom on the ammeter board. Thus a stranger entering a dynamo room could see at a glance at the ammeters which dynamos were carrying load; the switches on the common bus bar would indicate what branch circuits were in operation, while the position of the corresponding plug switches would show to which dynamo each branch circuit was connected. Finally, the multiple switches would show whether the dynamos were operating singly or in parallel; and if the dynamos were numbered, the whole situation would be grasped in a few seconds, and the stranger could operate the plant.

V.

Motors.

All motors on board ship will naturally fall under the head of constant potential motors, supplied from the vessel's mains, and either series, shunt, or compound motors may be used. The series motor is valuable for its great starting torque, but has the disadvantage of irregular speed. This, however, is of no great consequence in training guns or other heavy work. As soon as the motor commences to move the current is reduced to safe limits by the counter E.M.F. A starting rheostat is usually interposed as a resistance to ease the motor. The speed of rotation is similarly controlled.

The shunt motor, when made with low armature resistance, preserves a practically constant speed, with wide variations of load. It has, however, no starting torque, consequently a starting rheostat is commonly provided, by which a current is passed through the field coils before the armature circuit is closed at all, the next step being to send the current through the armature in series with a resistance, the latter being gradually cut out as the counter E.M.F. rises from the speed increasing. This motor is therefore adapted to starting with a light load, and afterwards preserving an approximately constant speed.

The compound-wound motor, with both its coils acting in the same direction, possesses the best points of both shunt and series motors, and is advantageous where starting torque and fairly uniform speed are desired, and especially where there is a probability that all load may be thrown off suddenly. It is clear then that if starting torque is essential, and constant speed unnecessary, the series motor is the best; that the shunt motor is best adapted to purposes calling for a constant speed; and that the double wound motor possesses in a lesser degree the advantages of each of the others.

It is suggested that electric motors will be advantageous for the following purposes on board men-of-war:—1. In all places where auxiliary engines operate continuously for extended periods, the steam and exhaust pipes necessarily passing through storerooms or living spaces. 2. For ordnance purposes, where the demands for power are not excessive.

3. In isolated places, such as military tops, where power is necessary.

It is considered that electric motors are inadvisable :—1. In engine or fire rooms, where steam is always available, and the conditions are unfavourable for the durability of motors. 2. In general, where the demands for power are excessive and steam is available, as in the windlass engine. 3. Where rapid and frequent reversals are necessary, as in the steering engine.

VI.

Care of Plant.

The conditions existing aboard men-of-war are especially trying to dynamo apparatus, and even with the best care, deterioration is more rapid than is usual ashore. The continuous operation of the dynamos, the high temperatures of the dynamo rooms, the presence of salt water and salt air, and the inevitable wear and tear attendant upon the crowded condition of the ships, are all difficulties to be encountered, but intelligent care will materially assist in overcoming them, and in minimising deteriorations.

Lieut. Murdock insists upon the careful arrangement of steam and drain pipes, which should be independent, as straight as possible, and without any drop bends. The drains must always be kept clear, and on starting the water must be worked through at a low speed. Operating at too low a speed is a common cause of the overheating of field coils. If these coils get overheated, this may be diminished by increasing the speed, and, if necessary, lowering the voltage ; whilst the armatures should be effectually protected from mechanical injury, good ventilation must not be sacrificed.

Nowhere in a dynamo is more care required than in the commutator. The brushes must not be allowed to spark heavily, and scoring must be guarded against. The tension should always be as light as possible. If sparking is due to defective insulation on the armature, causing either a heavy ground or a cross, the defect must be repaired, if on the outside, by covering it with shellac tape ; but if on an inner turn, the coil must be rewound. It must be remembered that it is possible to so arrange the field of the dynamo, as to have an E.M.F. generated in a coil as it passes under the brush, opposing that due to the short-circuiting, and thus the coil will be practically dead, and no spark will pass.

Most of the deterioration in the fixed wiring will be found to occur in the receptacle, switches, and junction boxes. Unless care is taken to have them always screwed up tight, moisture, or even water, is liable to find its way inside, where it is held, and slowly corrodes the copper of the conductors. Water-tight fittings must therefore be constantly examined. Rubber-covered wire must never be painted, as the oil rots the insulation.

The care necessary for the proper preservation of a complex electrical plant can be given only by thoroughly trained men. Whatever electricity may do in the future, it will always depend on human intelligence for the development of its power, and all complex electrical apparatus requires attention to keep it in working order, as well as technical skill for its operation.

A BRIEF GLANCE AT ELECTRICITY IN MEDICINE.

Whatever may be the nature of progressive work undertaken by either one or many individuals, an occasional review of the forces employed is useful.

The study and practice of electricity in medicine is undoubtedly a progressive work, and Dr. William J. Morton, of New York City, has been good enough to review its present condition for the benefit of the American Institute of Electrical Engineers. Much that he had to say upon the subject was interesting, and the views he expressed are worthy of attention on this side of the water also.

Naturally currents of high potential and frequency receive prominent consideration, but, first, a "brief glance" is taken at the properties of currents which are of use in medicine. These are given as follows :—A. Physical—1. Heat ; 2. Light ; 3. Magnetism ; 4. Induction (Electromagnetic) ; 5. Chemical, or Electrolytic ; 6. Cataphoric. B. Physiological—1. Contraction of protoplasm ; 2. Excitation of nerve and muscle ; 3. Electrotonus. In dealing with these in detail, we are told "magnetism, itself, whether from permanent magnets, the most powerful of electromagnets, or from solenoids, seems to have little or no important effect upon human tissue. The wonder is that it should ever have been expected to have such a great effect, since no one would select the ingredients of the human body as suitable ones to collect the electro-magnetic lines of force. I do not, however, accept as final the experiments of Kennelly and Peterson, for the reason that closed conductive circuits were not provided for in their experiments, and that alterations in the excretion of carbonic acid and urea were not looked for."

In connection with the vexed question of the resistance of the body, stress is laid upon the fact that tissues behave as conductors like a solution of the salts they contain, and that "by the law of divided currents, each component of the mass will receive its ratio of current." From this we are led on to consider electrolytic conduction in the minute structures of the body. "The salient and interesting feature I wish to bring out is, that the action upon the tissue is electrolytic, that the electrolysis takes place in the intrapolar region as well as at the ministering poles, and that the electrolysis is at the expense of the inorganic salts of these tissues. Now, these salts constitute but from 1 to 2 per cent. of every tissue, and we may, hence, see how it is that a comparatively small current strength, even of a few milliampères, conducted electrolytically by the solutions of inorganic salts, decomposing and diminishing them in amount, produces the profound effects seen in electro-therapeutics, for the function of the tissue depends upon its physical integrity, and it is its physical integrity which suffers by the passage of the current."

The secondary battery action of the body is also referred to, and the credit of its demonstration given to Larat, whereas, we believe, Dr. W. H. Stone was the first to demonstrate the phenomenon, before the Royal College of Physicians, so long back as April 1886.

Dr. Morton speaks most favourably of the usefulness of metallic electrolysis as introduced by Gautier, and upon which we commented in the Electrical Review a short time back. He agrees with his fellow countryman, Dr. Goelet, as to its many advantages, and states, with reference to the cupric form, "The results of this treatment, in my hands, at least, far surpass the most sanguine claim of any other treatment."

This part of the address concludes with some remarks on diagnosis, and an enumeration of the classes of disease in which electricity has been found useful. Of these we are told that "the pathology once established, either in fact or in hypothesis, a given property or properties of some given modality of the current is applied to effect a cure."

The second part deals with "High Frequency, High Potential Currents." Almost at the outset appears a statement which we can hardly consider sufficiently proved to warrant its prominent position. Dr. Morton, in speaking of the physiological effects of these currents, says : "Currents whose current-strength is fatal or dangerous to human beings at a slow rate of interruption, may be taken through the body without danger when the rate is largely increased. One may easily verify this statement with an ordinary medical induction coil, whose primary is supplied from a small alternator. A slow rate gives painful shocks, and as the rate is increased, the current becomes more and more bearable up to a point where almost no effect is appreciated." The latter part of the paragraph may be quite true, but, even then, it goes very little way towards proving the first statement, unless, indeed, precautions were taken to keep the current strength constant as the rate increased. Dr. Hedley * found that when he increased the rate of alternation to any marked extent, the current strength was proportionately diminished ; and, on the other hand, when special means were taken to keep the current strength constant, that increased rate of alternation did not materially diminish sensation. Alternating currents, especially at high potential, and of the small current strength admissible in applications to the

* *Lancet*, December 24th, 1892.

body, are difficult to measure, and, in fact, are very seldom measured at all. We have little, if anything, recorded in the way of actual measurements of high potential, high frequency currents, and, even though so eminent an authority as M. D'Arsonval states that he passed 3 ampères of such current through his body with impunity, we are not aware that he has published particulars as to the instrument used to measure that current, or by what method he calculated it. Dr. Morton's statement is evidently based upon that of D'Arsonval just referred to; but if we accept it, we must believe that, inasmuch as the current sparked over an air gap of about a centimetre, and therefore possessed an E.M.F. of about 10,000 volts, the total electrical energy applied to the body was 30,000 watts, or over 40 horse-power. This is a little too much for us to accept, just yet, at any rate. Man is a long suffering creature, but few amongst us are prepared to face a *remedy* of 40 *horse-power*. Another point is, where did this large amount of energy come from? Mr. Campbell Swinton, who has carried out experiments in many respects similar to those of D'Arsonval, used an *initial* energy (not the amount after transforming) of "not far off *half an electrical horse-power*." Yet, with this comparatively small amount, he found "that though practically no sensation is experienced when the body is introduced, so as to form a circuit between one pole of the high frequency coil and earth, it is very different when the body is inserted between the two poles of the coil." Dr. Lewis Jones says:* "It is doubtful whether D'Arsonval's estimation of the magnitude of the current of his apparatus is correct;" and again: "For the present it may be taken as not yet proved that high frequency of alternation can render electrical currents harmless; and it may still be accepted that the effect produced by the passage of a current through living tissue depends primarily upon the magnitude of the current, as measured in ampères, which is made to traverse them, and upon its density or concentration therein." We have not seen that M. D'Arsonval has ever offered any explanation of this difficulty, and think it strange that so cautious a scientist as Dr. Morton should have adopted the original statement so apparently without reservation, as to base upon it the definite conclusion that fatal, or at least dangerous, current strengths may be handled with impunity, if only their frequency be largely increased. Serious and even fatal accidents from electric currents are still more frequent than they should be, and it surely behoves all investigators to adopt extreme caution when making statements likely to encourage overconfidence in workmen and engineers who have the handling of machinery or connections carrying large currents.

Some interesting remarks of Mr. Tesla, made at a recent interview, are reproduced, as "to the possibility, already proved by experiment, of the transmission of energy through the air," wherein he sets forth that his plan is to "disturb by powerful machinery the electricity of the earth, thus setting it in vibration."

It will be news to many that Benjamin Franklin included among his many accomplishments the practice of electrotherapeutics, for in 1752 he "was treating paralytics by shocks from his Leyden jars," and the experiences of a young lady patient, whom he successfully treated for convulsions, are given with amusing detail.

A little later on attention is called to D'Arsonval's contention, that not infrequently, in what have appeared to be fatal accidents from electric shocks, and even in electrocutions the functions may have been only inhibited, and a sort of trance produced, from which the subject might be resuscitated by proper means. Dr. Morton suggests that the only way to prove this either way, is by postponing the autopsy until it is positive, from the evidence of decomposition, that the body is actually dead. Further, that the proper measures of resuscitation should be studied in our emergency hospitals and applied to linemen and others who seem to have received fatal shocks.

In concluding his remarks as to the effects upon the body of static discharges, Dr. Morton speaks highly of the value of the spray discharge, and deduces from his experiments and practice the following law, viz.: "That a normal temperature is slightly raised; that a temperature below normal is raised to normal; that a temperature above normal is lowered. These changes in temperature average from 1° to 2° Fahrenheit." The peculiarity of such a levelling action constitutes a sort of affinity between electricity and a normal temperature, which is difficult to comprehend, but as we are expressly told the researches upon which the "law" is based are not yet published in detail, we withhold further comment for the present.

A section upon Tesla's apparatus and currents, "Rapidly Alternating Electrostatic Stresses," contains the following:—"We can in our imagination picture a future group of patients pursuing any agreeable occupation, reading, conversing, playing games, and so on, in a room where two opposite walls are of metal, connected to the two terminals of a Tesla apparatus, and thus submitted to a furious molecular bombardment in the intervening space." Had Dr. Morton been in England in 1889, he might have seen such a group, very similarly situated, and subjected to very much the same conditions, though, of course, the Tesla apparatus was then unknown here. We find, on looking back to our issue of January 1st, 1890, an account of a lecture given on December 19th, 1889, by Mr. H. Newman Lawrence, wherein he described what was called at the then Institute of Medical Electricity, an "electrified room," invented by Captain Byng. We extract the following: "The apparatus consists, briefly, of a metal floor insulated from the other floor, and a ceiling of brass work, which is also insulated from everything else; and we charge these two by means of a large induction coil. . . . . What is happening now is that the whole of the atmosphere between these poles is under strong electric agitation by alternating currents, and all those human bodies now upon the platform are influenced by it without being aware of it. . . . . Experiments might be carried on, showing the action in the field, even when special efforts are made to insulate the patients." We think the electrified room may be safely regarded as an anticipation of Dr. Morton's imaginative development, for though the electrical conditions fell short of those obtainable from the more modern Tesla apparatus, yet they differ in degree rather than in essential characteristics.

Of course, the static induced currents introduced by Dr. Morton 10 or 12 years ago are given prominent notice, as, in fact, they deserve; but his methods in this connection are too well known to our readers to need recapitulation here.

This most interesting and instructive glance at electricity in medicine is brought to an end by conclusions, two of which we reproduce:—"A human body is an oxidising furnace, and the draught is increased electricity. If the draught is good, the fuel is completely burned, the apparatus does not choke up, the ashes are at a maximum, and the highest degree of energy is derived from the mechanism—in our case, a living, human, fuel consuming and oxidising organisation."

"Electricity, judiciously employed, promotes the activity of the physical processes underlying life and health. It may even constitute the motive power which drives the machinery of life. Be that as it may, we know that we can alter the running of the vital machine for weal or for woe by intelligently turning an electric current upon it."

* *British Medical Journal*, June, 1893.

THE VARIOUS METHODS OF CHARGING THE PUBLIC FOR ELECTRICITY FROM A CENTRAL STATION.

By ALFRED H. GIBBINGS, A.I.E.E.,
Electrical Engineer to the Hull Corporation.

(*Continued from page* 97.)

Method No. 3.—*Maximum Charge based on the Number of Hours the Demand is Used, and all Excess Charged at Half Price or a Different Rate.*

This method may be described as follows:—

A calculation is made which gives the total number of units consumed by an 8 C.P. lamp burning two hours per day throughout the year. This number of units is then multiplied by the equivalent number of 8 C.P. lamps in-

stalled in a consumer's premises, for which number of units he is charged the full price. All the units consumed above this total are charged at a reduced price. This method was in use by the now defunct Brighton and Hove Electric Supply Company, whose business has been taken over by the Brighton Corporation, who have lately adopted a very similar method of charging, devised by Mr. Arthur Wright, the Corporation electrical engineer, and fully described by Mr. Wm. L. Madgen in an able article in the issue of *Lightning* of December 28th, 1893. The arrangement consists in

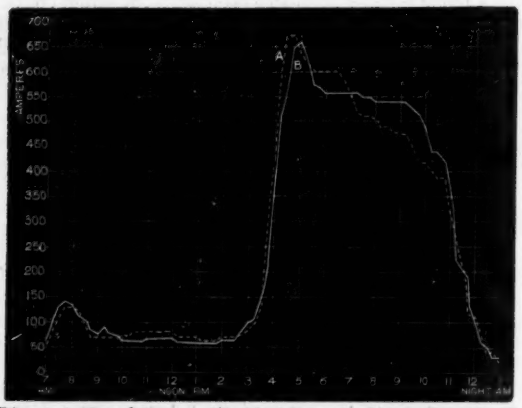


Diagram referred to on p. 97 of last issue, inadvertently omitted.

placing a recording ammeter in series with the consumer's meter, and the effect is to register the maximum amount of current which has been used at any given time. The indicating apparatus is very much like a self-registering thermometer, as the indicator remains at maximum registration until reset by hand. By means of this apparatus it is, of course, not necessary to know the number of lamps which a consumer has installed, as the lower price is based upon the maximum demand for current as indicated by the recording ammeter.

For instance, a person applies for current to supply 20 lamps, or, we will say, 20 ampères. Under the first basis of calculation, that is, on the equivalent number of 8 C.P. lamps installed, the consumer would have to use that amount of electricity which would be equal to 20 ampères for two hours per day throughout the year, before he would be entitled to any reduction. If we assume 313 days per annum at a supply pressure of 110 volts, it is evident that 1,377 units must be consumed before a reduced price is effected. But it is obvious that while a consumer may have 20 lamps installed, he *may* never have more than 10 in use at any one time, or, in other words his maximum demand on the station would be 10 ampères, instead of the 20 for which he applies. Applying this instance to Mr. Wright's system, it is clear that the 10 ampères would be registered on the recording ammeter as the *maximum demand*, and the number of units to be consumed before a reduction is effected is only half what it would be under the former arrangement, that is, 688. Assuming that the number of units consumed is 1,377, and comparing the two methods relatively at 6d. per unit maximum price, and 3d. per unit for all excess, we have, in the first instance,

1,377 units at 6d. = £34 8 6

In the second instance (Mr. Wright's method),

689	units at 6d. =	£17	4	6
688	„ 3d. =	8	12	0
1,377	„ =	£25	16	6

The practical purpose of the idea, therefore, may be summed up thus:—To induce the consumer to use the greatest number of units for the smallest amount of current, and thus to induce him to effect his own reduction.

The *advantages* of this method of charging are:—

1. Tendency to increase the day-load on the station, inasmuch as the number of units required per quarter or per annum to entitle the consumer to the reduction in price, would be effected by his using motor power in the day time, lights in permanently dark places, heating, and possibly cooking apparatus.

2. Consumers are treated very nearly upon an equal basis, whether their demand for current is large or small.

3. Tendency to eliminate the high peaks of the load curves, thereby giving more available horse-power at the station, and a higher efficiency of the plant.

4. Checks additional lamps being added to the installation without the knowledge of the supply company.

The *disadvantages* are:—

1. The system does not guarantee or indicate at what time of the 24 hours the number of units are consumed for which the full price is charged.

If the number consumed falls short of the number required to effect a reduction, the full price is charged, whether or not the lights have been burning at the time of the heaviest demand on the station. This is manifestly unfair, for if the current has been used either immediately before or after the time of the heaviest demand upon the station, the consumer should only be charged at the lower rate.

2. The greatest disadvantage, and an exceedingly serious one, is that the indicator registers the absolute maximum demand which occurs at any one time. That is to say, that if on any one day or occasion in a quarter, the maximum demand is abnormally high, say, for example, twice as high as on any other day in the quarter, still the number of units is calculated on that maximum registration, should notice have failed to have been given to the supply company beforehand. On such a supposition, double the number of units must be used to effect the reduction than would otherwise be the case. It is claimed for these indicators that their action is sluggish, but it is certain that they would register in the course of an hour.

This method is therefore not perfect. There can be no doubt, however, that it approaches far more nearly to a perfect system than any which we have hitherto considered. If the readings of the recording ammeter were taken day by day, and each daily consumption were worked out upon its maximum record, perfection would not be very far off, but of course, from a practical point of view, such an ideal method is as absurdly impossible as its advantages are desirable. But even if this difficulty were overcome, and the daily demand and the daily consumption could be registered at one and the same time, by a little imagination we can readily understand how such demand and such registration might not occur at the time of day when the heavy load is on the station, and therefore in this particular again the method would still be defective.

At this stage it will be useful to shortly reiterate the chief facts, which in the course of my observations have been thrown up into very considerable prominence. In the first place, it will be noticed that much stress has been laid upon the value of those few consumers who help to make up the day load. An attempt has been made to show how all existing methods of charging are open to the grave objection that they may work out results the very opposite of what is intended. Attention has been drawn to those unprofitable consumers who make the peaks in the load curves at the time when these peaks are not wanted.

It will, perhaps, not have escaped notice, that hitherto I have avoided all reference to mechanical facilities or difficulties, as well as to the initial cost or efficiency of any apparatus employed, as these do not mainly affect the question of the best method of charging, but are distinctly of secondary importance.

I now approach that portion of these papers in which I propose to discuss the whole question of charging for electricity in a broad, comprehensive way, and in which I shall enunciate a solution.

It will very materially assist in elucidating the subject if we consider it from the two main, but opposite stand points, viz.:—

1. The works cost.
2. The public interest.

The Works Cost.

In treating of the various systems now in vogue, references have been made to the probable effects upon the efficiency of the central station. It has been stated that these effects are modified according to the nature of the demand upon the station. In those cases where the station has always a considerable day load, and consequently where a fair proportion of the generating plant is always at work,

the load curves may be a more or less reliable guide as to the efficiency of the particular method of charging for current. But under neither system can any engineer say definitely to what extent inducements are held out to the consumer to economise, or to the public to become users. Advocates of existing methods in truth can only speak of the probable effects, however near perfection they may arrive, and not of the absolute effects.

Further, it must be remembered that stations having a considerable day load are in a very small minority, and even these are open to considerably increasing their output at times other than that of full load. There can be no question but that inducements to this end must very soon be held out in a far more definite way than is the case at present, if the existing proportions of day load to full load are to be increased, or even kept up. But what is of importance in such exceptional stations as those we have referred to becomes, for the large majority, a matter of very serious consideration.

We will now proceed to elucidate the matter by dealing with it in the concrete. Let us assume that the available indicated horse-power of a station is 1,000. Multiplying this by the total number of hours (8,760) in the year, gives us 8,760,000 horse-power hours. Assuming, on the other hand, that the full capacity of the plant is used on the average three hours only per day, then the total number of *actual* horse-power hours = 1,095,000, or $\frac{1}{8}$th of the absolute capacity. As an assumption, this errs, if anything, on the safe side, as very few central stations, in fact, are yet reaching even $\frac{1}{8}$th of their full capacity in the year.

We must now consider this unused available horse-power side by side with those items of cost which would not practically be increased in the sum by generating the remaining $\frac{7}{8}$ths available output.

The items are as follow :—

1. Wages (except out-door staff).
2. Salaries „ „
3. Repairs and maintenance.
4. Rent, rates and taxes.
5. Directors' remuneration.
6. Sinking fund.
7. Interest on capital.

It will readily be admitted that these are the expenses which really affect the cost per unit delivered to consumer. Yet these remain, to all intents and purposes, constant; practically neither more nor less, even when the plant is being utilised to the full. The result, of course, is, that where the output is increased eight-fold, the rate of cost per unit delivered, so far as these items are concerned, will be reduced to one-eighth. For example, for any given output, say 100,000 units, the charge per unit may be made up as follows :—

Generating cost (coal, oil, stores, &c.)	1·2d.	per unit.
Subsidiary charges (as foregoing list)	3·8d.	„
Total ...	5·0d.	„

But for 200,000 units, the cost would be :—

Generating cost	1·2d.	per unit.
Subsidiary charges ...	1·9d.	„
Total ...	3·1d.	„

Every time the output is increased a similar decrease on the rate of cost will of course ensue. As a matter of fact, the generating cost would be further decreased owing to a higher efficiency being obtained from engines, boilers, &c. It will not be overlooked that the important point underlying the above calculations is that no increase of plant is assumed, the increased output being simply provided by an increased period of generation. The question is, therefore, how shall the different charges per unit delivered be arranged, *first*, for those consumers (A) who require supply at the time of maximum demand on the station; and *second*, for those (B) who require the supply at other times, so that in each case the arrangement shall be fair, shall offer the greatest possible inducement to the public to become users, and yet shall be consistent with the commercial success of the undertaking. The problem seems to be satisfactorily solved as follows :—

In the *first* case the consumer (A) to pay for the nett cost of generating the current, including all subsidiary charges, and an addition of a minimum profit, the amount to be settled by the estimated expenditure for each ensuing year. According to the instance given above, this charge would be 5d. per unit. In the *second* case, the consumer (B) to pay the nett cost of generating (not including subsidiary charges), the amount to be settled by the average cost in the previous year. According to the instance given above, this would be 1·2d. per unit, but at this price it is clear that no margin of profit to the company, except in actual working efficiency, would be gained. It is therefore proposed that this consumer should be charged the larger proportion of the company's estimated profits. This would, of course, be variously estimated, according to the existing proportion of the day load to the full load in any particular instance, but in connection with the example given above, we may assume it to be 1·8d. per unit, bringing up the charge to 3d. per unit for *all* current used at times other than that of maximum demand on the station.

Each of the methods of charging for current already described in this paper, endeavours to embody the principle just enunciated. How far they succeed and where they fail has been pointed out to a certain extent. It is still necessary, however, to consider the matter from the public point of view.

The Public Point of View.

In dealing with this section of the subject, I shall bring to bear my own experience extending over a very considerable period. One has to discriminate, of course, between real and imaginary grievances, but the facts with which I have been brought into contact by communication with the public have been of the utmost service to me in working out my own conclusions.

(To be continued.)

THE SCIENTIFIC STUDY OF ARC LAMPS.

By RANKIN KENNEDY.

VIII.

Electro-magnetic Devices.

Electro-magnetic devices in arc lamps are usually the weak points in the design; until within quite recent date little or nothing was known regarding the designing of magnets and coils for special purposes. The study of the dynamo and transformer for practical purposes has advanced the science of magnetism most wonderfully; the works of Ewing and Prof. S. P. Thompson has taught us the science of magnets from a practical basis, and we can now give reasons for particular designs, or design coils and magnets for special work with considerable accuracy.

Arc lamp designers, however, do not often trouble themselves much about their electro-magnetic devices, trusting more to mechanical devices for perfect working. This is a mistake visible in many lamps. The matter is of the utmost importance; the electro-magnet devices in arc lamps are, in fact, required to be as accurate and sensitive as a voltmeter and an ammeter. The fine wire coil and core must act as a delicate voltmeter and respond firmly and promptly to a difference of half a volt on a 45-volt circuit. The thick wire coil in some lamps only strikes the arc and does not interfere in the feed, in that case it is of little importance, but in other lamps it acts with the shunt on the feed; in such a case it is an ammeter, and must be sensitive enough to act with a difference of one-fourth of an ampère on a 10-ampère circuit. Now, considering this fact that the feed is governed by a voltmeter and an ammeter, it is surprising how well they perform in practice; the forces are small, and on account of that most lamps, in fact all good lamps, are exceedingly sensitive at the feeding point, and very little cause is required to bring about irregularities.

If we calculate the feeding of a shunt coil with a one-volt difference it comes out very small. Take a coil of 4,000 turns of 225 ohms resistance at 45 volts, the current is 0·2 ampères; it will then be 0·2044 amperès at 46 volts, a difference of ·0044 ampère; this multiplied by number of

turns, 4,000, gives us 17·7 as the ampère turns added to the shunt coil by a rise of one volt at its terminals, and this is the magnetising force available for feeding the lamp, not the total force of the coil, but the force added by a 1-volt rise, or subtracted by a 1-volt fall.

17·7 ampère turns being the force at our disposal, it behoves us to make the very best use of such a small force; we cannot afford to waste any of it, hence the importance of magnet design.

In the thick wire coil the variation of current produces the action, but in a good lamp there should be exceedingly little variation of current; in fact, in a large number of arc lamps in series there is no variation of current whatever. The current coil must be considered simply as opposing a constant force against the variable force of the shunt coil. That being the case, we may in all series lamps replace the main coil or current coil by a weight or by a spring, or by a weight and spring combined, in fact, the best design of series lamp requires no current coil, and any such lamp in which a current coil is used in the feed may be re-designed to work with a weight or spring instead.

In next article I shall describe several arrangements for working with shunt coil alone.

Some lamps have been designed with only current coils and no shunt coil, but any lamp so designed must work upon a variable current. No lamp with only a current coil in the regulator can possibly work steadily or stand any tests in a series system.

The common fallacy so often seen in patent specifications about the current getting *less* in the main coil, and more in the shunt coil as the carbon burns away, is very generally accepted, but any series lamp which does not regulate the feed of the carbons so that a constant current is maintained, is not worth considering at all in series working. Single lamps or two lamps in series on a constant pressure supply must have a variable current to some extent, otherwise there could not be a change in volts at the terminals of the fine wire coil. On a constant pressure supply the change of volts is due to the change of current passing in the resistance placed in series with the arc, and, therefore, a slight fall in current is necessary before a rise in pressure takes place, this resistance placed in series is usually passed over in treating arc lamps by calling it a *steadying resistance*, it is explained to be put in to steady the current; such an explanation is nonsense, no resistance can steady a current. One writer recently stated that "this steadying resistance promptly absorbs a large number of volts when the current in the lamp *tends* to increase, and absorbs a reduced number of volts when the current diminishes," and so on goes the confusion of ideas regarding simple matters. Let us by a simple calculation see what the resistance actually does in a lamp. First and foremost it must be stated that no resistance can absorb, promptly or otherwise, a large number of volts when the current *tends* to increase, the current must actually increase before any change in the volts occurs, and the rise and fall of the volts is exactly proportional to the rise and fall of the current inversely.

Take a lamp with a main and shunt coil on a 65-volt circuit with a resistance in series of 1·5 ohms, this resistance will cause a fall of 15 volts with 10 ampères. As the carbon burns away we want 1 volt increase of pressure to feed by the shunt coil, how much must the current diminish?

The total volts remain unchanged, so that a rise of 1 across the arc causes a fall of 1 across the resistance, the volts simply change places (see fig. 30) where B is battery reading on v^1 65 volts, on v^2 15 volts across resistance, on v^3 50 volts across arc. Now, as the arc lengthens the current falls until the readings would be 14 volts on v^1 and 51 at v^2. As we know, resistance, R, is 1·5 ohms, by Ohm's law the current will now be $\frac{14}{1{\cdot}5} = 9{\cdot}\dot{3}\dot{3}$ ampères or a fall in current of $\cdot\dot{6}\dot{6}$ ampères, so that if we had 200 turns on the main coil we would get $200 \times \cdot\dot{6}\dot{6}$ ampère turns for feeding force on the main coil, that is, 132 ampère turns, so that in a lamp of this design we would have an immense force to work with and very good feeding, but in practice such a large force is not now allowed in good lamps. A good 10 ampère lamp should work on a 55-volt circuit at a pressure of 45 volts on the terminals, that is, with 1 ohm resistance in series, and two of them should work in series with the same resistance on a 100-volt circuit with a 1-volt feed, we then get a fall of current equal to $\frac{1}{2}$ ampère for a rise of 1 volt across the shunt coils and arcs. It will be seen from this that the main coil and the resistance play a very important part in working lamps on a constant pressure circuit, and also that if we work with a low resistance at R we can get great power in the main coil, as the current rises immensely for a slight increase of volts on v^2. Advantage is taken of this fact in some highly belauded lamps, the makers claiming that they work with very small resistance in series, but if such lamps are carefully tested by current measuring it will be found that although they may feed regularly on a half-volt variation the current varies at least half-an-ampère to one ampère or more.

It would seem, then, that for constant pressure lamps the main coil would give us most power, and therefore it should be retained, but in series working, where we have constant current, the main coil is inert and may well be abolished. It is for these reasons that some lamps have failed to work; the makers, in ignorance of these simple laws, not knowing what to do to alter lamps to different circumstances.

To work with a considerable variation in current, and a small resistance at R, is economy in power; in the first case with 1·5 ohms and 15 volts fall with 10 ampères, we lose 150 watts in each resistance, in the other case with a 10-volt fall we lose 100 watts, with two lamps in series that is only 50 watts in each lamp.

It seems to the author quite possible to design a lamp to work with much less resistance by a proper application of a main thick wire coil only, and some experiments have confirmed this view. We have seen by our figures that in a constant pressure lamp with one ohm or so in series the shunt coil force is always very feeble, in fact it is just sufficient to prevent pumping. The problem is to prevent this by other means, and that can be done mechanically.

In series lamps variation in volts alone affect the feed; the shunt coil in that case is of great importance, and we may allow a greater variation in volts without in any way impairing the steady burning of the carbons.

In constant pressure lamps we must take the current as practically unlimited, as the fall in pressure due to 100 or 200 ampères more or less on a main supply is negligible. It must never be forgotten that a lamp on a street supply has, perhaps, several hundred horse-power behind it, and we need not consider any drop on the mains due to arc lamp working from continuous current.

Fig. 30 will well repay the closest study by the student and also by some teachers. The change of place taken by the volts is the important point; suppose we gradually open

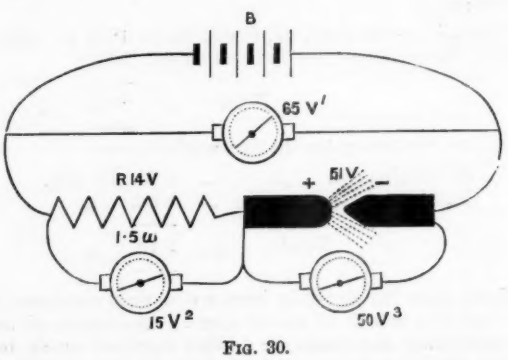


Fig. 30.

the arc, v^2 will gradually rise, and v^2 will fall; 1 volt on v^3 more will be shown on v^2 as 1 volt less, and so until the carbons are so far apart that the arc breaks, v^2 will then show nothing. All the volts having gone over to v^3, which now shows 65 volts, then let us gradually close the arc, beginning when the voltmeters are as in fig. 30; as the arc closes, v^3 falls and v^2 rises, until v^3 shows perhaps 10 volts, and v^2 55 volts. This experiment shows clearly the shifting of the volts, and the action of the resistance.

Fig. 31 shows an experiment to demonstrate the action of the lamp on a constant pressure with no resistance in series. This experiment is best made by means of a hand regulated

lamp, such as is used in search lights; on bringing the carbons together the volts fall on v^3 and gradually rise as we open the arc; the fall is not great because we are working on constant pressure; it soon rises to 65 volts, and we can

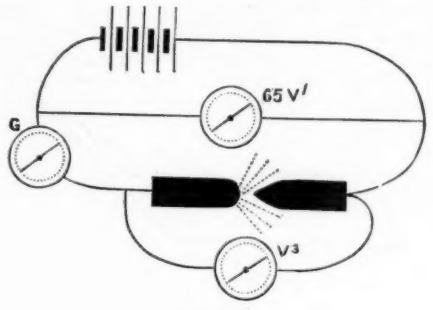


Fig. 31.

open and close the arc through quite a long range without in any way changing the volts. If we put in an ammeter, G, it will be found that the current varies largely while the volts are constant, if we open and close the arc. A lamp designed to feed by the variation in current can be used instead of the hand feed, and no resistance used in series with it.

In making this experiment the circuit in which the carbons are placed must be of low resistance, say capable of carrying 100 ampères; the source of current should be a central station, a large compound dynamo or a large accumulator.

It will be observed that the ammeter is the instrument to be used in this experiment, as the volts are constant we must adjust the arc by observing the current.

Sixty-five volts will give a large arc of great power with about 50 to 60 ampères, but the experiment can be made with 45 or 50 volts and 10 ampères at the feeding point, but as the volts are constant any slight change in the arc makes a very great fluctuation in current. The feeding has to be very prompt, so that, on the whole, it is better to waste a little power on a resistance so as to reduce the magnitude of the fluctuations by shifting the volts from the arc to the resistance, or *vice versâ*, as the current increases and decreases.

The main thick wire coil is retained in many series lamps simply for striking the arc, or drawing back the carbon in the event of an overfeed; and the shunt coil is retained in many constant pressure lamps where it could very well be dispensed with, as it will be seen that at the small limits of volt variations allowed the shunt coil is a very feeble regulator, while the main coil is very powerful.

Theoretically, a series lamp should have only a shunt regulator, and a parallel lamp only a main regulator, and practice is surely but slowly coming up to this ideal.

THE ELECTRICITY OF DROPS.

Some Important Light on the Origin of Electrification Generally.

Drops afford many advantages for the investigation of electrical effects, especially of those which involve the contact of dissimilar substances. Perhaps the greatest of these advantages is that when the drops are formed they present a perfectly clean surface to the gas by which they are surrounded, so that the conditions are much more definite than they can be when the surfaces have been long exposed, and have had time to get contaminated by dirt or coated with films. These advantages have commended the study of the electricity of drops to Prof. J. J. Thomson, of Cambridge, who contributes an exceedingly interesting paper on his results to the April issue of the *Philosophical Magazine*.

The subject has already received some attention from Lenard (*vide Wiedemann's Annalen*, xlvi., p. 584), and Prof. Thomson has largely made use of the methods of experiment adopted by this physicist. The experiments described by the latter relate to the electrical effects which occur when a drop of liquid falls upon a plate already coated with a film of the same liquid.

At the foot of waterfalls, as is well known, peculiar electrical effects occur. Here the normal distribution of the atmospheric electrical potential is disturbed in such a way as to indicate a distribution of negative electricity in the region at the foot of the fall. These effects cannot be due to the waterfall acting like the falling drops in Lord Kelvin's water-dropping electrophones; for they are found to occur when the waterfalls are inside caves whose sides are dripping with moisture, in which case the water would be falling inside an equipotential surface. This notion is the starting point of Prof. Thomson's investigation.

Without following the professor through the details of his exhaustive experiments, we may turn with advantage to his results. They show that the electrification developed by the drop depends (1) on the nature of the gas surrounding the drop; (2) on the nature of the drop itself. On the drop side of the surface of separation of the gas and drop there is a coating of one kind of electricity close to this, but in the gas there is a coating of the opposite kind of electricity. The quantity of positive electricity on one coating is equal to the quantity of negative electricity on the other.

Experiments with liquids of various chemical constitutions point clearly to the conclusion that the *electrification owes its origin to chemical processes*. Over the surface of the drop a substance is formed which is in a state intermediate between that of complete chemical combination and complete separation between the surrounding gas and the liquid forming the drop; a state in which the constituents have electrical charges of the same sign as in actual chemical compounds, but in which the connection between the constituents is so loose that they can easily be shaken apart. The greatest electrical effect will occur when there is a tendency towards chemical combination, though not of sufficient intensity to result in the time taken by the drop to fall from its starting point to the plate, in the formation of a definite chemical compound.

The quasi-chemical action which produces the electrification is greatly influenced, if not altogether determined, by the solvent.

Prof. Thomson argues that distilled water, concerning which electricians have hitherto held pronounced views, is a substance which is far from being chemically saturated and inert, but that, on the contrary, it can by its chemical action set up those chemical changes in the gas by which it is surrounded or in substances dissolved in it which give rise to electrification. This argument is illustrated mathematically by curves.

There seems no reason for limiting the possession of this double coating to liquids. It is possessed by liquids of the most diverse characters, as is shown by the electrification developed by drops of water, mercury, molten metals, turpentine, &c. If, however, we suppose that solids possess such a coating, it is evident that the rubbing off of part of one of these coatings when two solids are rubbed together, would show itself as electricity developed by friction. Indeed, it seems possible that a large part, if not the whole, of the electricity developed by friction may be due to this cause.

The professor concludes his paper with some speculations (this is scarcely the right word) concerning the electrification of metals, &c., when exposed to the influence of ultra-violet light, and concerning the origin of the large drops of rain which frequently accompany thunderstorms.

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 89.)

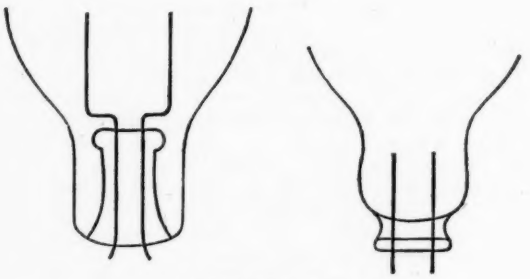
The Mounting of the Flashed Filament in the Bulb.

The mounting of the filament in the bulb is the simplest and least delicate operation in the manufacture of an incandescence lamp.

* *L'Electricien.*

This work is generally entrusted to glass-blowers. But the reduction in the price of the lamps has led to the employment of cheaper labour, and now several makers employ women or even boys, who succeed, after a short apprenticeship, in acquiring the necessary skill. They have only in fact to know how to use a blow-pipe in order to be able to commence the work, and then, if they are dexterous with their fingers they soon learn to shape the bulb to the required form, and in heating the glass to the proper temperature for making good fusions.

The operation of blowing differs a little according to the form which it is desired to give to the clutch to which are fastened the two platinum wires of the support. The clutch adopted by Edison was rather delicate to make. The extremities of the two wires of the support were held at the end of a glass tube fastened by its other extremity to the bulb by means of a double melting. This clutch is not much used now; but it may be worthy of consideration when it is required to place short filaments in large bulbs (fig. 4).



Figs. 4 and 5.

At the present day the method proposed by Swan is in almost general use. This is much more simple, more solid, and less expensive. The two wires of the support are clasped in the glass of the bulb itself; some makers do the work a little differently, each wire having its own special holder (fig. 5).

The tube used for extracting the air may be placed in different ways. It is generally placed at the extremity of the bulb opposite the clutch; however, in the Khotinsky lamps amongst others, it is fastened between the two platinum wires of the support, which sometimes somewhat complicates the work of mounting. The advantage of this system is that it does away with the pointed top of nearly all lamps, which may increase the risk of breakage; but this advantage is counterbalanced by serious inconveniences in the course of manufacture. Lastly, if the two platinum wires of the support are connected by crystal, as at certain works, the work of the blower is again somewhat modified.

We will now discuss the manufacture of a Swan lamp, supposing, as is generally the case, that the bulbs are bought outside.

Let us first see what tools are required by the glass-blower.

These are not very numerous or very complicated; they comprise a blow-pipe, some tongs, a rod of metal, and a file or knife for cutting glass. A glass-blower's workshop is besides provided with a supply of gas and one of compressed air.

The compressed air may be produced either by a compresser or by a pressure ventilator. The compresser is preferable, as it gives air of a higher pressure, and the pipe may therefore be of small diameter. In either case it is expedient to place a reservoir between the machine and the blow-pipes, in order to avoid variations of pressure.

The glass-blower's blow-pipe consists of two copper tubes, A B, C D, soldered together at an angle about equal to that shown in the figure; a third tube, *a b*, placed inside A B, is movable and may be placed in any position whatever. The tube, C D, bears a tap; it is through this tube that the gas is conveyed to the blow-pipe and spreads out in the tube, A B, all round, *a b*. This tube, *a b*, conveys the compressed air into the flame of the gas; the blowers generally take it in a glass tube of suitable diameter and centre it in the outer tube, A B, by means of wedges of paper or cork. A second tap placed within reach of the workman in the course of the supply of compressed air enables its admission to be regulated; a gutta-percha tube connects this tap with the tube, *a b*.

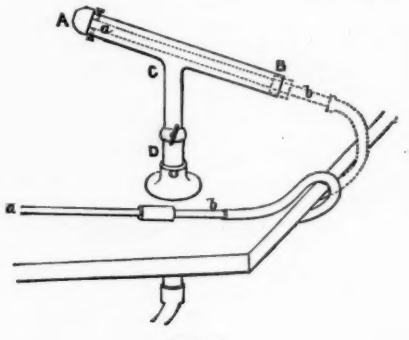


Fig 6

The shape of the flame of the blow-pipe is of considerable importance. In short, as crystal is always being worked, this flame must have an oxidising effect over a considerable length in order to perform the work without fear of reduction; it must, moreover, be thoroughly homogeneous all round and very steady in order to heat all points equally. The regulation of the flame is one of the delicate points in the glass-blower's work, but when once this regulation has been effected it remains unchanged as long as the pressures of gas and air remain constant; moreover, if these pressures should vary, they have only to manipulate the taps and the centreing of the flame remains invariable as long as the air in the room remains still.

A pair of metal pincers are used by the glass-blower for fusing the two platinum wires of the support; another pair enables him to fix the filament in the centre of the bulb, and a metal ring is required to enlarge the neck of the bulb before the filament is placed in it.

Instead of the blow-pipe we have described, a series of little converging pipes can be used (American fire). This arrangement is particularly suited to cases where the Edison clutch is employed. In this apparatus a current of compressed air is conveyed into a gas flame composed of a number of very small jets.

We will now describe the glass-blower's work. The workman having regulated his flame takes one of the bulbs supplied by the glass-works, the shape of which resembles that shown in fig. 7. He places to the flame of the blow-

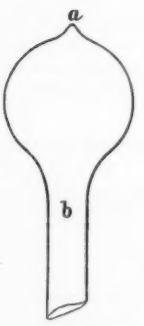


Fig. 7.

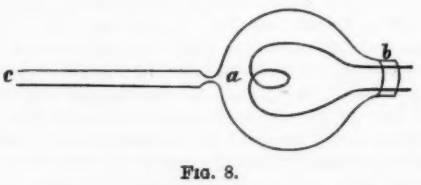


Fig. 8.

pipe the slightly pointed top, *a*, of the bulb. When this point is sufficiently softened he blows through the neck, *b*, and thus pierces the bulb at *a*; he then applies to the hot

edges of this hole the end of a glass tube which he has previously heated, and placing the whole in the flame, he joins the tube to the bulb (fig. 8). When this junction is effected, *i.e.*, when the crystal of the tube and that of the bulb are well welded together, he draws out that part of the tube, *a c*, which adjoins the bulb as shown in the figure. This tube serves to bring the lamp into connection with the pump, and the narrowing of it enables the lamp to be more easily detached when the vacuum is formed. The glass-blower then takes the bulb furnished with the tube, *a c*, and holds in the flame of the blow-pipe the neck, *b*, so as to reduce it to the length required for the lamp. By drawing out the neck, the bulb is closed at *b*; but if the tube, *a c*, is blown before this mass of glass is cooled the extremity of the portion of the neck retained is again pierced through. The workman again heats this portion and softens it sufficiently to be able to enlarge it with a metal rod, for he must be able to introduce the filament into the bulb without fear of breaking it. He then, with a pair of tongs, takes the filament by its support and passes it into the bulb, taking care to place the platinum wires of the support at the mouth of the neck, *b*. By placing this neck, *b*, in the flame of his blow-pipe again, he melts the glass again and holds the two platinum wires in the melting glass. He then gets the filament, which is now held by its support, into the centre of the bulb by blowing through the tube, *a c*, while the glass is still soft; at the same time he presses the glass against the two metal wires with the tongs, so as to obtain a perfect fusion for them; he has now only to make the head of the lamp, *i.e.*, that part of the neck that he has just been working into the required shape, which is easily done by again heating this part and blowing it. It is expedient to slightly hollow the glass in the head of the lamp at various points, so as to form cavities in which the plaster can run when the lamp is mounted on its stem. The blowing is then finished and the bulb must then be allowed to cool slowly. For the sake of avoiding all waste in the course of subsequent operations, it is best to rapidly anneal all the lamps; for this purpose the glass-blower caps the head of the lamp that he has just finished with a little glass cowl that he has previously heated in the flame of his blow-pipe. It is an advantage for each workman to have at his disposal a little annealing stove heated by a gas burner.

(*To be continued.*)

REVIEWS.

Electric Light Installations. By Sir D. Salomons. London: Whittaker & Co.

This is one of the Specialists' series, evidently meant for the amateur installation engineering specialist. It describes and illustrates the products of a few manufacturers of installation machinery and apparatus. Gas and steam engines and dynamos, motors and transformers are illustrated and described much the same as in a manufacturer's catalogue. Lord Kelvin's measuring instruments are fully illustrated and described. Interspersed throughout the descriptive matter are practical observations, suggestions, and hints from the author on the use and care of the various appliances. As these are based upon actual experience, they are of considerable value. Some of the apparatus ought really to be left out as obsolete; for instance, of the Joel ammeter on page 100, the author says "This instrument is illustrated because it is the simplest possible form of ammeter *and is rarely used*," and this, too, after stating that the illustrations given are of the leading ammeters.

The work as a whole gives a fairly accurate view of the machinery used at this date by the installation engineer, without entering upon the discussion of scientific principles to any extent. The illustrations are very numerous and, as a rule, familiar to electricians.

Lord Kelvin's latest electricity meter is described and illustrated, but the statement of the author that "the principle of making the core of a solenoid an electro-magnet is new" is an error. We have seen electro-magnetic solenoid cores at least 14 years ago, or thereabouts, used in arc lamp regulators applied for the same purpose to get rid of hysteresis errors.

The Magneto Hand Telephone. By Norman Hughes. New York, Spon & Chamberlain; London, E. & F. N. Spon, 125, Strand.

This is an extremely handy little book and one which should prove extremely useful to those who wish to be able to set up telephonic communication of the simplest kind and do not require to study the subject deeply. The work is eminently practical and gives very numerous details and "wrinkles" necessary to enable good sound work to be done. The author has been tempted in one or two places to give information which is unnecessary, as for instance a description of a bichromate battery, though it is only fair to say that he states that his reason for describing the arrangement of this form of cell is that it is useful for experimental purposes in some cases. The diagram of the connections of the magneto bell on to a metallic loop circuit given on page 42, is, we think, an objectionable arrangement; it does away very greatly with the advantage gained by using a metallic loop. Earth put at any point on a metallic circuit is bad, and is almost certain to bring an inductive disturbance. The writer states that the double-pole bell receiver is not so superior to the single pole arrangement as might be imagined. This is rather indefinite (an argument of the "size of a lump of chalk" nature), and it is scarcely correct, for it would lead one to suppose that it is hardly a combination worth having, whereas it is most decidedly the best form of receiver to use.

No. 111. *Journal of the Institution of Electrical Engineers.* London: E. & F. N. Spon, 126, Strand.

This number contains:—"On Parallel Working, with Special Reference to Long Lines," by W. M. Mordey. "A Universal Shunt-box for Galvanometers," by Prof. W. E. Ayrton and T. Mather. "The Best Resistance for the Receiving Instrument on a Leaky Telegraph Line," by Prof. W. E. Ayrton and C. S. Whitehead.

LAYING AN ATLANTIC CABLE IN TWELVE DAYS.

On July 2nd, says the *Scientific American*, the *Faraday* completed the laying of a new Atlantic cable, the actual time occupied in the work of laying the deep sea portion being but twelve days. When the *Great Eastern*, in 1866, completed the laying of the first successful Atlantic cable, the entire world joined in congratulations. The event was justly looked upon as marking an era in the progress of the world. Since that time, however, the making and laying of ocean cables has become a practical, everyday business, and the new cable was not only laid in the shortest time, but is a much better cable than any of its predecessors, having the largest copper conductor and being the speediest ever laid for its length.

Although the *Faraday* left Woolwich on June 12th, she did not, owing to unfavourable weather, reach the vicinity of the previously laid and buoyed shore end of the cable, off Waterville, Ireland, until the 18th, and then, the buoy rope, having been wrenched off by a passing propeller, had to grapple for the cable itself, at a depth of about 250 fathoms. Such work now presents no substantial difficulties. The heavy grapnel, attached to 600 fathoms of chain and rope, was three times dragged across the cable's path, when the cable was hooked and hauled up, two miles inside of the end that had been buoyed. The end communicating with the shore was at once tested and spliced to the cable in the tanks, the other piece hauled aboard and the buoys picked up, when, at 10.30 a.m. on the 20th, the vessel was ready to start on the actual work of laying the deep sea cable. At the rate of about seven knots an hour the cable passed up round the core in the centre of the tank, along the troughs and directing sheaves, under the sheave of the strain-measuring dynamometer, and sank to the ocean's bed. For several hours the depth varied from 250 to 500 fathoms, when a great

declivity was reached and 1,000 fathoms were indicated, followed by a varying bottom, nearly three miles deep in places. Thence it gradually rose to 1,600 fathoms, dropping subsequently to over 3,000, as hill top and valley in the ocean bottom were passed, until the shallow water of the Newfoundland Bank was reached, some 75 miles from the buoyed end of the previously laid shore end on the American side, 502 miles from Canso, Nova Scotia. During all this time communication was constantly kept up with the Waterville station, the news of President Carnot's assassination being received on the *Faraday* the evening of its occurrence. When at 1,585 knots' distance from the Irish coast, and the soundings indicated a depth of 891 fathoms, the lighter deep sea portion of the cable was spliced to a shallow water type, which was continued to the still heavier Canso shore end. Foge, icebergs, and bad weather prevented the finding of the buoy on this shore end, but after a good deal of dragging the cable was hooked and drawn aboard on the 30th, just ten days from the actual start on the other side, although the final splice was not completed until the morning of July 2nd.

The new cable was laid for the Commercial Cable Company, being the third cable of that line. It was manufactured and laid by Messrs. Siemens Brothers & Co., who have very extensive works at Woolwich, England, for the manufacture of electrical appliances. The *Faraday* was specially constructed by the Siemens Brothers for the work of cable laying, and has three large tanks for the storage of cable, with many ingenious appliances to facilitate the paying out, grappling, and hauling up and making all the delicate tests required in all stages of the work. The new cable has a much greater weight of copper conductor or core and of gutta-percha insulation than any of the cables previously made. The shore ends and intermediate sections of the new cable comprise about 700 nautical miles and the deep sea portion is nearly 1,600 nautical miles in length.

ELECTRIC WELDING*.

By Mr. BENJAMIN ALFRED DOBSON, Member of Council.

Experience in Electric Welding.—Practical everyday working for nearly three years of the process of welding by electric force, enables the author to give certain indications and appreciations of the method considered as a practical workshop operation. During this period his firm has had two machines in operation, worked from the same generating dynamo, and employed on different classes of work: one is specially arranged for piecing bar iron and steel; and the other and smaller machine for special classes of work of a more delicate description, such as brazing and the piecing of clean-finished work, where the fire heat would have destroyed the quality of the work on the adjacent material.

Mechanical Power.—The statement made with regard to the requisite mechanical power placed great difficulties in the way at first, as it was found that this power had been much understated. Having something like 35 indicated horse-power to spare on a certain engine, and understanding that 30 horse-power would be the utmost wanted in order to piece a 2-inch round bar, the author determined to drive the dynamo from this engine, particularly as it was in close proximity to the smithy and stretching shed, where this piecing was previously effected by means of the ordinary smith's hearth. By this practical test it was found that not 30 horse-power but as much as 80 horse-power seemed to be required for the larger sizes; and until this was understood, the engine was frequently stopped from want of steam, occasioning great loss and inconvenience. The company having control of the welding machine suggested that they should supply a semi-portable engine and boiler; and that this should be tried, with the option of purchase after a certain length of time if approved. This was agreed to, and a portable engine by Messrs. Marshall, of Gainsborough, capable of working up to 100 indicated horse-power with 80 lbs. pressure, was supplied and placed at a distance of about 45 yards from the welding machine. This got over the difficulty of power, but was of course more expensive on the score of separate attendance and other cost. But even with this engine it was found that, when piecing the larger diameters—and as yet nothing over 2¼ inches has been pieced—if the work was to be done within a reasonable time, the engine was seriously checked in speed. It was therefore with a view to be certain as to the basis of calculation for the necessary expenditure on driving power that the experiments which follow were conducted.

After some months' working with the portable engine, it was proved satisfactorily that the process was a practical one, and, so far as the results to the author's firm were concerned, a success. As considerable enlargements were about to be made to the establishment, a portion of a large dynamo room for electric lighting purposes was set apart for the welding dynamo and exciter; the distance of the leads from the dynamo to the welding machine was approximately 100 yards. Having a quick-running vertical engine of the kind made by Messrs. Fleming & Ferguson, making 140 revolutions per minute, with an extra heavy fly-wheel and abundance of surplus power, the author has been able to work the larger diameters without affecting the steadiness of the arc lamps driven off the same engine; and as the load will vary 80 horse-power in the tenth of a second, this result speaks well for the arrangement of the engine and for its governing powers. The greatest variation in voltage of the lighting dynamos has been two volts.

Electric Welding Process.—The following account of the principle of electric welding is taken verbatim from a paper prepared for a former meeting of this Institution by Mr. W. C. Fish, on the Elihu Thomson electric welding process.

"*Principle of Electric Welding.*—Every substance, whatsoever be its physical nature, is heated when traversed by an electric current; and the law defining the quantity of heat so produced is as precise and as clearly ascertained as is that of gravitation. The product $C^2 R$—that is, the square of the current flowing, multiplied by the electrical resistance of any considered portion of the circuit—is directly proportional to the heat-units therein produced. For a continuous current, the resistance of an infinitesimal length of any conductor is inversely proportional to the area of its cross-section, and in metals increases with increase of temperature. Thus in iron the resistance increases some tenfold with a rise of temperature from 0° to 1,000° centrigrade. For alternating currents, which are usually employed in welding, the resistance of a conductor no longer varies inversely as its cross-section; but this divergence may be neglected without error in the description of the process, if not in the design of the welding machine."

Dynamo.—The Thomson-Houston welding dynamo is an alternating current machine. The field-magnets project inwards from a cast-iron frame having six pole-pieces. Its speed is 1,000 revolutions per minute, and it gives at full load a current of 200 ampères at 300 volts, having a frequency of 100 complete alternations per second. The machine is excited from a continuous current dynamo giving 40 ampères at a pressure of 110 volts. The large welder is capable of piecing iron or steel bars up to 2 inches diameter.

Transformer.—The primary coils consist of 41 turns of 0·452 inch copper wire; these are coiled round an iron core, formed of thin sheet-iron plates bolted together. The secondary circuit consists of a single massive copper tube 1⅝-inch diameter inside and 3⅜ inches outside, passing through the centre of the core, and connected at the two ends with massive castings 6¼ inches broad by 3 inches thick, which support the welding clamps; one clamp is kept stationary during the welding, and the other is movable. The pressure is obtained by a screw and hand-wheel, forcing the movable clamp towards the fixed clamp.

Elihu Thomson Welding Process.—It has just been pointed out that the heating effect of the passage of electric energy through a bar of any particular resistance is proportional, not to the amount of energy, but to the square of the current simply. In order, therefore, to obtain the greatest heating effect with a given amount of energy, it is advisable to use a very large current at a very small pressure. With this object an alternating current is employed in the Thomson process, and transformed down from something like 300 volts to 1 volt, or even a fraction of a volt. This reduction in pressure is accompanied by an exactly proportional increase in current; and the heating effect of the process is due to the passage of this enormous current through the bar which is to be welded. The bar itself is held between two clamps of copper having a small resistance; and the portion of the bar to be heated for welding is that which lies between the two clamps, and which always has a much greater resistance than the clamps themselves or any other portion of the circuit. Even, therefore, if a solid bar be held between the two clamps, it becomes heated somewhere between the points at which it is held. If however, as is the case for welding, the bar is not a solid one, but has a break in it at the point where it is to be welded together, then the greatest resistance in the circuit is at the surfaces of this break, where the contact is imperfect. Heat is developed here at once; and the surfaces being continuously pressed together by special apparatus, the metal as it softens is squeezed into closer contact, and eventually the two original separate pieces are thereby welded together. The resistance at the original break would of course become diminished as the metal becomes continuous by welding, if it were not even more increased by the rise of temperature, and the consequent fall in conductivity. In consequence of the latter, however, the temperature of the metal at the weld continues to rise throughout the process until the current is finally cut off. The increase of resistance with temperature automatically necessitates also the uniform heating of the entire cross-section of the weld, because any cooler portions will be traversed by a proportionately increased flow of current until uniformity of temperature is obtained.

Good and Bad Welds.—It must not be imagined that a good weld can always be made by pressure alone. No doubt if the material were perfect in character and thoroughly homogeneous, this might be the case. The iron and steel of commerce are not perfectly pure; and in order to make certain that the work may be subsequently depended upon, it is advisable that the burr formed by the pressure should be reduced by hammering in swages. One machine has a screw and hand-wheel for supplying the pressure requisite to give the welding action; and this machine has been found powerful enough, so far as its mechanical arrangements are concerned, for piecing iron and steel bars up to 2 inches diameter. The distance apart of the clamps—or, to put it in another way, the length of the projection of the material to be pieced—varies according to the nature of the material and the diameter or area of the

* Paper read at the annual meeting of the Institution of Mechanical Engineers, Manchester, July 31st, 1894.

weld to be made, and is, as can be well understood, proportionately less for the larger sizes and greater for the smaller. There are limits of course in both directions; but these limits are well within the machine itself, and a short practical experience teaches the workman the distance he ought to set his machine. Roughly speaking, for the smaller sizes the projection should be about three times the diameter of the piece, and for the larger sizes twice the diameter. When welding pieces of different diameter, the centre of resistance can be brought to the point of contact by varying the projection of the different diameters, and thereby equalising the resistance in the projecting portions. Thus in piecing 1 inch and 1½ inch bars, the 1 inch bar might have to project some 3 inches, and the 1½ inch bar 2 inches, in order to bring the centre of resistance to the point of contact. This principle of difference of projection applies also when piecing metals of different quality. It is found in practice that the current should not be turned on to its full strength at the commencement of the operation; if this is done, the material under treatment is unnecessarily damaged, and the general life of the machine itself is injured. As the surfaces in contact become heated and the resistance is increased, the rheostat or regulator of power or choking coil, is gradually turned to increase the volume of current; and immediately before taking out of the clamps for the purpose of swaging, the full power required is turned on for a second or two.

Method of Working.—The method of working is somewhat on the following lines:—The main carrying the current to supply the exciting coils of the alternator is conducted to the room in which the electric welder is placed. The main is attached to the terminal of a rheostat or resistance coil, and a return main is connected to the other terminal and is returned to the alternator, and from this another main is led back to the exciter. The rheostat now being in series with the exciting coils governs the current of excitation, and thus controls the output of the alternator. A double-pole switch has one pole connected with the primary main leading to the primary coil of the electric welder, and the other pole connected with the exciting-current main leading to the rheostat; so that this switch breaks the exciting circuit and also the primary circuit at the same time. When two pieces are ready to be welded, the double pole switch is switched in, and the attendant adjusts the rheostat until the desired heat is obtained.

The ordinary surfaces of bars, whether cut by shears or broken with the chisel and hammer, are found sufficiently uniform to permit of welding, without further preparation. Should there be dirt or rust upon the surfaces, it is easily expelled when the metal is sufficiently soft to allow of the end pressure of the screw necessary to form union, and the dirt, scale, or oxide makes its way to the exterior.

Work done.—In common practice at the author's works the following materials have been heated, and the undermentioned work has been performed. Welding of steel of every quality, iron of every description from crown to best roller iron and charcoal iron, steel and iron together, wrought-iron and cast-iron; different diameters of the same and different materials. Riveting in many varieties; work which previously had to be riveted cold, and which consequently left the strength of the parts uncertain, is now done easily and certainly with the requisite heat. The piecing of countershafts and lathe spindles, where the question of exactness of length is of the utmost importance; screwing taps, rollers and spindles broken in the neck bearings, and brazing of all descriptions, have all been successfully treated. The alloys which have been tried have been done more for the purpose of experiment than for any useful end; and were not successful, owing to there not having been time to persevere sufficiently for ascertaining the precise temperatures and conditions under which the process could succeed.

Power required for Electric Welding.—These tests have been confined to the welds required in everyday work, and have varied from ½-inch steel and iron to 2 inches, as shown in Table 1. The measurement of the alternating-current power supplied to the welding transformers is attended with some little difficulty, owing to the short space of time during which the current and electromotive force are practically steady. As also every piece of iron varies in resistance, though cut from the same bar, the power registered is continually varying in the welding of bars of the same diameter. Another cause accounting to some extent for the different powers obtained with the same size of shafting, is that the rheostat is not always worked from the same segment of the coils through the adding or deducting of the resistance, and consequently causes a greater or less excitation of the field of the alternator, thereby producing a greater or less electromotive force.

A Siemens electro-dynamometer was connected in series with the thick-wire coil of a Siemens wattmeter, the latter being in series with the primary coil of the electric welder. Connected across the terminals of the welder was the thin-wire coil of the wattmeter, in series with a non-inductive high resistance. A Siemens voltmeter for the measurement of alternating volts was also connected across the terminals of the welder. By this means the virtual volts and the virtual ampères were estimated with sufficient accuracy; and at the same moment a reading was taken from the wattmeter, giving the true watts absorbed in the transformer. At the time of taking the instrument readings, indicator diagrams were taken from the engine, which afford a considerable check on the results obtained from the wattmeter. In order to estimate accurately the power taken for each weld, it is necessary to add the power required to excite the alternator, and the power lost in transmission. For this purpose the resistance was measured of the mains supplying the current to the primary coil of the welder, and also the resistance of the mains carrying the exciting current; the former was 0·2 ohm, and the latter 2·6 ohms.

The electrical horse-power given in Table 1 is obtained from the true watts shown by the wattmeter, divided by 746, and the loss in the mains and in the exciting current is got by calculation; the loss in friction in the amount of power required to work engine, alternator, and exciter, at no load.

Strength of Welds.—The following particulars are taken from Mr. Fish's draft paper, and, owing to the care with which the work seems to have been done, may be depended upon as correct. He says:—"Twenty electric welds, bent hot, were bent through an average angle of 144 degrees before cracking, Table 2. In cold-bending tests however, the average with 20 pieces was only 66 degrees before failure of the weld occurred. As a cause for this comparatively early failure, Sir Frederick Bramwell suggests the extreme localisation of heat in the electric welding process, and proposes annealing as a remedy. More recently a few welded bars, annealed either in the forge or by re-heating a length of five or six inches in the welding machine immediately after the swaging and working of the weld was completed, have been tested by bending cold under the steam hammer. The results were much more favourable than those obtained by Mr. Kirkaldy, the average angle of bend at which failure occurred being about 130 degrees. In testing welds of smaller sizes, the writer has experienced but little difficulty in bending the bars, while cold, round their own diameter; and he suggests that in the Farnley welds failure in the bending tests was hastened by error in the method employed in making and finishing the weld, as well as by any possible effect due to the localisation of heat.

"In testing Bessemer steel welds, Prof. Kennedy obtained the following results:—

Diameter of bar	1·00	0·75	0·50 inch.
Average tensile strength of welded bar in percentage of unwelded ...	92	97·5	100 per cent.

The decrease in efficiency of weld with increase in diameter would seem to be due to a proportionately smaller butting pressure during the welding. A high percentage of strength at the weld, 80 per cent. or upwards, and probably more than would be required in any practical test of the metal, can be obtained with most of the hardest steels. Most metals that are commercially pure, and certain alloys, weld with little loss of strength, except that which may be due to the annealing effect of the process; this loss may amount possibly to a total of 10 or 15 per cent.

"*Conductivity at Weld.*—Tests made by Prof. Sylvanus P. Thompson and others show that the electrical conductivity at the weld is practically the same as that of the unwelded material. This result is possibly an index of the soundness and homogeneity of the electric weld."

TABLE I.

Power Expended in Electric Welding.

Work welded.	1894.	Duration of current.	Electrical horse-power. Watts / 746	Loss in mains and in exciting.	Loss in friction.	Total.	Indicated horse-power.
	May.	Seconds	E.H.P.	E.H.P.	E.H.P.	E.H.P.	I.H.P.
2-inch wrought-iron bar	24	243	59	10·8	18	87·8	...
2-inch wrought-iron bar polished all over	25	256	55	10·8	18	83·8	...
2-in wrought-iron bar	29	255	59	10·8	18	87·8	88
⅞-ths inch round iron bar							
Average of 15 welds	16	57	17·7	6·3	18	42	42
Average of 7 welds	25	50	21	6·3	18	45·3	...
1-inch steam-pipe, wrought-iron ...	24	67	20·1	6·8	18	44·9	...
Ditto	24	66	19	6·8	18	43·8	...
Ditto	24	61	24·7	6·8	18	49·5	...
Ditto	29	86	15	6·8	18	39·8	49
Ditto	29	66½	25·5	6·8	18	50·3	49
1-in. Bessemer steel shaft	24	64	22·3	8	18	48·3	...
Ditto	24	65	22	8	18	48	...
Ditto	29	62	23	8	18	49	49
Ditto	29	54	27·6	7	18	52·6	51
¾-in. Bessemer steel	24	37	15·5	6	18	39·5	36·5
Ditto	24	38	15·2	6	18	39·2	36·5
Ditto	29	50	17	6	18	41	48
Ditto	29	54	15	6	18	39	43
½-in. Bessemer steel	24	21	9·2	4·7	18	31·9	...
Ditto	24	21	10·1	4·7	18	32·8	...
Ditto	24	36	8	4·7	18	30·7	...
Ditto	24	22	10·3	4·7	18	34	...
Ditto	29	25	9·2	4·7	18	31·9	...
Ditto	29	30	8	4·7	18	30·7	34

TABLE II.

Bending Tests of Electric and Hand Welded Round 1½-inch Bars of Farnley Iron.

Electric Welds were Butt. Hand Welds were Scarf.

Extracted from Messrs. Kirkaldy and Son's Report.

Welding.	Bent cold.			Bent hot.		
	Test No.	Angle of bend.	Effect of bending.	Test No.	Angle of bend.	Effect of bending.
Electric Welded.	Y			Y		
	404	37°	Broken	444	180°	*Cracked
	406	65°	Cracked	446	180°	Uncracked
	408	65°	Broken	448	160°	Cracked
	410	34°	Cracked	450	175°	Cracked
	412	58°	Broken	452	94°	Cracked
	414	115°	Broken	454	180°	Uncracked
	416	65°	Cracked	456	60°	Cracked
	418	57°	Cracked	458	180°	Uncracked
	420	37°	Broken	460	96°	Cracked
	422	58°	Broken	462	180°	Uncracked
	424	58°	Cracked	464	180°	†Cracked
	426	50°	Cracked	466	81°	Cracked
	428	90°	Cracked	468	163°	Cracked
	430	150°	Broken	470	98°	Cracked
	432	95°	Broken	472	180°	Cracked
	434	59°	Cracked	474	90°	Cracked
	436	70°	Cracked	476	120°	Cracked
	438	35°	Cracked	478	180°	Uncracked
	440	55°	Broken	480	180°	Cracked
	442	64°	Cracked	482	117°	Cracked
	Mean of 20	66°		Mean of 20	144°	
Hand Welded.	640	60°	Cracked	662	100°	Cracked
	642	180°	Uncracked	664	75°	Cracked
	644	90°	Cracked	666	180°	†Cracked
	646	150°	Cracked	668	180°	†Cracked
	648	170°	Cracked	670	180°	†Cracked
	650	75°	Cracked	672	180°	†Cracked
	652	180°	Cracked	674	180°	†Cracked
	654	180°	Uncracked	676	90°	Cracked
	656	180°	Cracked	678	180°	†Cracked
	658	180°	Cracked	680	180°	Uncracked
	660	70°	Cracked	682	95°	Cracked
	Mean of 11	138°		Mean of 11	147°	

* Very slightly cracked. † Slightly cracked.

Conclusion.—The practical experiments made in the author's works show almost a better conclusion than the tests shown in published tables from the testing machine of the United States arsenal; for in bending cold here the weld has rarely given way. But in explanation of this it must be borne in mind that all the piecings of plain bars are here more or less swaged. It is well within the mark to state that there is not one out of five hundred welds which turns out a failure or even defective.

The question of cost, which, of course, is of importance to commercial engineers, has not been alluded to in detail. The author admits, however, that the payment of royalty, the cost of horse-power, and the depreciation, which on electrical apparatus is heavy, together bring the cost considerably over the net cost of the ordinary smith's hearth work, while the actual payments in wages and so on are considerably less. The loss in weight of iron is about one-twentieth only. It may be taken that on straightforward welds the total cost will be between 10 and 15 per cent. more than the ordinary smith's work; whereas in delicate work and difficult operations, such as have been alluded to, the cost will probably be one-third of the smith's work. But the real advantage of the apparatus, at any rate as at present arranged, is not so much an economy as a method of securing an absolutely reliable result, and occasionally saving considerable expenditure by its special adaptability.

LEGAL.

The Cassel Gold Extracting Company, Limited *v.* The Cyanide Gold Recovery Company, Limited, and Others.

(*Continued from page* 106.)

Third Day.—Wednesday, July 25th.

In the Chancery Division of the High Court of Justice the trial of this action was resumed before Mr. Justice Romer.

Mr. Louis Janin, jun., examined by Mr. Bousfield, said he was a citizen of the United States, and his uncle purchased the Simpson patent in 1890. His uncle attempted to work the Simpson process, but did not succeed. Ultimately, his uncle abandoned the purchase. Rae, in 1887, had abandoned the use of cyanide of potassium, but retained the electrical features of his earlier patents.

Cross-examined by Mr. Neville: He did not know definitely what was done with Simpson's patent—except what his uncle told him. He was a metallurgical chemist by profession, and he thought that Simpson's method was effective for getting a portion of the gold, at least, into solution.

After the date of Rae's patent it was known, was it not, that a solution of cyanide of potassium was effective for getting the gold into solution?—I knew it myself of my own knowledge. My knowledge was special and technical on that.

You knew that?—It was not common knowledge.

I think you gave your views about the cyanide process in an article which you contributed to the *Mineral Industry*, a New York publication?—I did, in 1892.

You begin this way: "It is difficult to find a period in the history of chemistry since the radical cyanogen was discovered, in which the solvent power of potassium cyanide on gold has not been mentioned." That is accurate?—Yes.

Radical cyanogen was discovered long before 1887?—Precisely.

"Hagen, as early as 1805, states that gold is dissolved not only by free chlorine and *aqua regia*, but by a potassium-cyanide solution," &c. That is correct?—Yes.

And you give a number of other authorities; so your knowledge, although not common, seems to have been shared by a good many other people?—The solvency of gold in itself, but not the gold in ores.

But a solvent which would dissolve gold would dissolve gold in crushed ore, would it not?—Not necessarily so.

Any process would which did not involve the destruction of the solution for the recovery of the gold?—That, generally speaking, is true to-day.

You go on to say: "Elkington, in 1840, was, however, the first to make practical use of this reaction in his galvano-plastic operations." That means the first to make practical use of the knowledge that cyanide of potassium would dissolve gold?—So I believed at that time.

"He dissolved either oxide of gold, or metallic gold in a state of fine division, in a 20 per cent. solution of potassium cyanide. Faraday, in the *Transactions* of the Philosophical Society for 1857, describes an experiment made in 1856, in which he used a dilute solution of cyanide of potassium for dissolving gold. As to the practical application of this process to the reduction of ores, it is found that United States letters patent, No. 61,866, dated February 5th, 1867, were granted to Jalio and Rae, of Syracuse, New York, for the treatment of auriferous and argentiferous ores by potassium cyanide." That is correct, is it not?—Yes.

"In brief, Rae's method consisted in treating the ores with a solution of cyanide, aided by the electric current, and in a subsequent electrolytic precipitation of the metals from the cyanide solution." That is an accurate description of Rae, is it not?—Yes, or nearly so.

Witness said that this was an anonymous editorial, written according to the policy of the paper for which he was the managing editor.

In answer to Mr. Neville, he said he would hold the truth of the statements to-day.

Mr. Neville said he did not see any evidence of hurry. He saw evidence of intelligence and far-reaching research, and so far from being anonymous, the heading was "The Cyanide Process, by Louis Janin."

Witness said it was written as an anonymous editorial, and then incorporated in the article.

Mr. Neville: It goes on to say, "Even at that date this use of cyanide of potassium was not considered new."

Mr. Justice Romer: That is perfectly correct?—Yes.

Mr. Neville put more of the article to the Witness, who said that he had changed his opinion on some of the points.

Sir R. Webster: What is the date of that?—The articles were written in the latter half of 1892.

Mr. Neville: Your article goes on: "I have thus followed the history of potassium cyanide as a solvent for gold up to the period of Messrs. MacArthur and Forrest's experiments in Glasgow. After patenting their process in England they applied for patents in nearly every country which contains gold and issues patents. Their application for an American patent was dated November, 1887, but their claims were so badly worded and so ridiculously comprehensive, and their discoveries withal so ancient, that their claims were limited to a dilute solution of cyanide of potassium." That is true, Mr. Janin, that when Messrs. MacArthur and Forrest came to patent this great invention in America, they could not get a patent except for a solution of a particular strength and of a particular description?—I presume they tried to patent what was their own discovery, the use of dilute solutions.

Witness went on to say that he now held that the Rae process and the MacArthur and Forrest were essentially different, and that the Simpson and MacArthur and Forrest were essentially different. Asked as to Rae, he said that he saw that process employed for the reduction of sandstone ore containing silver, but the Rae he was referring to was a subsequent patent, in which Rae had abandoned the use of cyanide of potassium.

Re-examined by Sir R. Webster: In the Rae process he saw, electricity was being used. The Simpson experiments were conducted in a laboratory, but on a working scale. His article of 1892 was written when he was opposed to the MacArthur and Forrest patent in America. The managing editor at that time held very strong opinions.

In answer to his Lordship, Witness said he had no rancour himself, but the tone of the paper was dictated by the owner.

Re-examination continued: At the time of writing he had experimented himself, and had investigated many of the publications to which he referred. As a metallurgist, he did not think Faraday's

passage would guide anyone to the practical use of cyanide of potassium for dissolving gold out of ore. Not every solvent of gold could be practically used for dissolving gold out of ore as a commercial process.

Prof. William Crookes, examined by Sir R. Webster, said he had had a very considerable experience in the metallurgy of gold. There was no question that the MacArthur and Forrest specification disclosed the operation and the action of a solution of cyanide of potassium upon gold. It was not known in 1887 to chemists or to practical miners that a solution of cyanide of potassium would practically and effectively dissolve gold out of gold ore. He never heard of Rae before he saw it in connection with this action. If it had been worked, he believed it would have come to his knowledge, because in 1890 he went into the question of gold extracting very carefully. It seemed to him that the essential part in Rae's process was the stirring of the ore, so that the particles of metallic gold should get on to the cathode and touch the anode, and in that way the gold would be dissolved in the cyanide of potassium. In his opinion Rae would lead anyone to imagine that electricity was necessary, and would not lead anyone to the application of cyanide of potassium as a practical solvent of gold out of gold ores. Witness then corroborated the evidence of previous witnesses for the plaintiffs.

Cross-examined by Sir Edward Clarke: He considered that the discovery made by MacArthur and Forrest was that a fact that had been known for a great many years to scientific men had been enlarged to make it apply to gold ores. The fact that had been known was that cyanide of potassium would dissolve gold finely divided and in the presence of oxygen. That fact was brought into prominence by Faraday.

The patent taken out covers practically every solution of cyanide of potassium in order to treat every character of ore?—Yes.

And the solution is only a solution in water; it is a simple solution?—Yes.

Witness went on to say that in Rae the particles of gold would be dissolved by virtue of the solvent action of the cyanide of potassium whether they touched the anode or not, and that Lord Kelvin had showed that the action of the current would retard the action of the solvent. He agreed that a particular strength of solution would have a selective action.

Mr. John Stewart MacArthur, F.C.S., and a member of the American Institute of Mining Engineering, said that he was one of the patentees, and had been engaged for 20 years in devising processes for the extraction of gold from its ores. The other two patentees acted conjointly with him in working out this invention. He first began to experiment with the chain of experiments which led up to this patent in 1886. Before he experimented he had no knowledge that cyanide of potassium could be used practically to extract gold from ore. By experiment, he found it. Looking now, with his present knowledge, at the anticipations, he did not believe that literature would have led anybody to apply solutions of cyanide of potassium to the practical extraction of gold from ores. Towards the end of 1886 he was consulted by the Cassel Gold Company. At that time no practical means of extracting gold from tailings poor in gold was known.

Was the residual gold going to waste?—It was.

The chlorination process would extract it?—Yes, but it was too expensive.

To what percentage of gold in ore will your process work now?—It is profitably extracting gold from ores containing only two or three pennyweights to the ton.

Witness then detailed the steps which led up to his discovery, and said that a dilute solution, about 1 per cent. of cyanide of potassium, had a selective action in the extraction of the gold. He understood Rae's to be a simultaneous solution and deposition process. When Rae's process was carried out the gold was to be found on the cathode. He denied that Rae's and Simpson's specifications, with the knowledge of 1887, would have led anybody to the use of cyanide of potassium as a method of dissolving gold out of ore without electricity. He did not know of Rae until 1889, nor of Simpson's experiments until Mr. Janin gave his evidence. He went to Mr. Harland's laboratory to see the defendants' process.

Have you experimented on several occasions in order to see whether or not the electric current had any operation in the dissolution or dissolving of the gold and of the ore?—I have.

Has the electricity or electric current as worked, or purported to be worked, in Pielsticker's process any effect at all upon the solution that is produced in C and runs into A?—We could find no beneficial effect.

Did you find any deposit of gold upon the cathode, G?—None, and that is where the process purports to dissolve the gold.

Did you yourself repeat or see the experiment spoken to by Lord Kelvin?—I did.

Does that demonstrate that the electric current does not assist the solution?—I believe, from these experiments, that the current does not assist the solution.

Your process will operate on all ores, but better on some than on others?—Very much better.

Cross-examined by Sir Edward Clarke: He was led to the conclusion from the experiment that the gold had not helped the solution, because there was as much gold in the ore when electricity was used as when, under similar circumstances, it was not used. At the date of his English patent he was not aware of the Rae patent, and the Simpson and the Sanders patent.

Mr. Justice Romer wanted to know more about the experiments with the defendants' machines, and asked witness whether he tried it on his principle with the electricity in tank A, and then without the electricity in tank A.

Witness said he did.

Keeping all the other conditions the same?—I could not keep all the other conditions the same, because in tank C the defendant passes an electric current, and I could not allow myself, in the spirit of fair play, to use the electric current at all. I could not allow myself to be accused of regenerating the solution, and then using it.

Sir Edward Clarke: But according to the defendants' process the solution is regenerated, is it not?—According to the defendants' statement it is, but not according to my practice of their process.

But that is the difference between your practice and theirs?—I do not know what their practice is.

Why do you doubt their statement of their practice?—Because I get opposite results.

Sir Edward Clarke: I think the test should have been to use the defendants' process.

Witness said he tested a parallel experiment, but not the Pielsticker process. He used the Pielsticker process without electricity. Asked as to whether he made experiments with the knowledge that cyanogen would act as a solvent of gold, he said that they knew that a solution of cyanogen would, in special circumstances, have a faintly solvent action on gold, and they had to determine by experiment with each quality of ore what strength of solution would suit it best. The distinction he drew between Rae's process and the Pielsticker process was the absolute necessity for electric contact between each particle of ore in the Rae method with the anode. In the Pielsticker process the ore could not possibly touch the anode, because there was a filter of cocoanut matting which prevented that contact. In the Pielsticker process each particle of metal in tank A did not become an anode and cathode itself, he thought, by the electric current from three Smee cells. There was no mention of selective action in the provisional specification, because he never looked upon selective action as an invention; the selective action of a simple cyanide of potassium on gold contained in ores was a discovery of theirs. The selective action varied in different qualities of ores. A year after this patent he took out a patent for procuring the deposition of gold by the use of zinc shavings.

Before that, had you made any commercial use of it?—We had worked about 20 tons in Glasgow.

That was the extent of your user?—Yes.

Cross-examined by Mr. Bowick: He had not discovered that gold would dissolve more rapidly in cyanide of potassium than it did before. He had not improved on Faraday's information in that respect. He did not think it would be possible, from Rae's method, to precipitate the gold from its solution, but Rae's would dissolve the gold. Their claim was, broadly, for using cyanide of potassium in dissolving gold from ore. In their American specification they disclaim that in conjunction with an electric current or any other chemical active agent.

In answer to His Lordship, Witness said that in their experiments there was continual motion, but no circulation in the sense the defendants used that word; it was a different kind of motion. The experiments could be made again, if necessary.

By Sir R. Webster, in re-examination, Witness said that his improved method of recovery by zinc had no effect whatever on the obtaining of the solution.

Sir Henry Roscoe, recalled for cross-examination by Mr. Neville, said that what Rae had in his mind was to effect the solution of his gold by the joint action of the electric current and the cyanide of potassium. There was nothing to point to the fact that without electricity the thing would answer.

In answer to His Lordship, Witness said that Rae's specification might indicate that the action of the electricity was only to facilitate the natural solving action of the chemicals on the metals, but it was distinctly clear in his mind that Rae thought that electricity was positively essential.

Cross-examination continued: Witness was asked whether it occurred to him that Rae had not the audacity to claim cyanide of potassium alone, because it was a well-known gold solvent, and he said that it was not a well-known solvent of gold in the condition in which it was found in ores.

Mr. George McCulloch, chairman of the African Gold Recovery Company, which has the rights of the plaintiffs' process in that country, spoke to the utility of the patent and to its extensive user.

This was the plaintiffs' case.

The Court adjourned for the day.

Fourth Day.—Thursday, July 25th.

Sir Edward Clarke submitted that the plaintiffs had made out no case. He said that of course there were different questions involved in this case, but the objections which the defendants made to the specification, and upon the knowledge which was admitted to have existed at the time, were objections which were to a great extent independent of the scientific evidence. His objection to the plaintiffs' specification was based on two grounds (1) that the alleged invention was not the subject matter of a patent; (2) that the specification was insufficient and misleading. They alleged further, a divergence between the provisional specification and the complete specification, that the second claim in the complete specification was not in any way indicated or referred to in the provisional. He submitted that upon an examination of the patent itself, it could not possibly stand. Looking at the provisional specification, it would be seen that that was a claim for the use of any solution containing cyanogen or any other substance or compound containing or yielding cyanogen. That was the widest claim that could possibly be made. It was admitted that before the date of the patent it was perfectly well known that a solution containing cyanogen had the property of dissolving gold. Under these circumstances, he submitted that there was no subject matter for a patent at all, that for a person to say, "I take out a patent by which I, as against all the world, claim to myself the exclusive right of using a solution containing cyanogen," was bad, it was not the subject

of invention, and there was no invention. To obtain a patent there must be novelty. What novelty, what ingenuity could it be suggested there was in this? None. The properties of cyanogen had been known for half a century, and if there was ingenuity, it was in trying solutions of different strengths, and then claiming them all, because that was really what was done in the provisional specification. He submitted that the provisional specification contained no statement of a patentable invention. In the complete specification there were one or two important departures from the provisional specification. There, for the first time, a dilute solution was mentioned. The patentee himself said that the question of selective action depended on the character of the ore which had to be treated, and that experiments were necessary to see what solution was required. The second claim was for a solution of a particular strength, and was almost as wide as the first.

Mr. Justice Romer: He claims the application of any solution containing cyanogen for the purpose of dissolving gold and silver from powdered ore and compounds.

Sir Edward Clarke: That is so, and in the face of the fact that all the world knew that a solution of cyanogen had been used for the purpose of dissolving gold. I say it is impossible for any man to assert for himself the exclusive right of using such a solution for such a purpose.

Mr. Justice Romer: Seeing the magnitude of the case, I shall of course take your evidence, although I may be with you on some points.

Sir Edward Clarke: Be it so.

Mr. Bowick had nothing to add to Sir Edward Clarke's speech.

Evidence was then called for the defence.

Mr. Claude Vautin said he was a F.C.S., and had been a metallurgical chemist for over 20 years. Sixteen years ago he was aware that the gold contained in ores could be dissolved in a solution of cyanide of potassium. Before 1887 he knew of the theoretical relation of the parts of cyanide required by the parts of gold to be dissolved. Practically, two equivalents of cyanide of potassium to one of gold would form the double cyanide, which was soluble. Dixon's paper in the *Chemical News* revealed this information. In 1885 witness was in Melbourne, and he then carried out experiments on the lines suggested by Sander's patent. He found that some of the gold was dissolved. He first became acquainted with Simpson's patent in 1887, and he had made the solution Simpson specified for, and he agreed with Sir Henry Roscoe that in case of the presence of acids, Simpson's solution would be more efficacious than the plaintiffs'. The result of his experiments was that, with finely divided natural gold, the presence of ammonium cyanide in a solution containing cyanide of potassium, did not decrease the solvent action of the solution on gold when acid was present. Gold, in its natural state, would rapidly dissolve in Simpson's solution. In 1887 the price of commercial cyanide of potassium would be about 1s. 6d. per lb. That kind would be used for this purpose. If you had to destroy the solution to recover your gold, the process would be most impracticable. Witness had dealt with thousands of tons of ore.

With regard to Rae's patent, in your opinion, has the passage of an electric current through a solution of cyanide of potassium any effect upon the dissolving of gold submitted to the solution? Through thin gold, not forming the anode?—Yes. From experiments I have made I must say my opinion is that there is a beneficial effect. The gold leaf submitted to the current was broken up and dissolved rapidly.

Witness then went on to say, with the greatest possible respect, that he had taken the apparatus used by Lord Kelvin, and found it so faulty in construction, that it was absolutely impossible to arrive at any definite results. The chief ground of witness's complaint appeared to be that there was a connection between the solutions from the two vessels. After reading Rae's specification, he should say that most of the gold from suitable ores would have gone into solution by that process.

If a man followed out Rae's directions, used the cyanide of potassium and the electricity?—I have no hesitation in saying that gold would go into solution.

Is that your opinion, whether the electric current was part of the business or not?—It is.

In the remainder of his evidence the Witness confirmed the previous witnesses, that in 1887 there was no practical method of getting the gold out of solution, and said that he had never heard of an experiment on behalf of the plaintiffs where there was any electrical connection in tank C, therefore the conditions of the defendants were not fulfilled, and it was impossible that comparative results could have been obtained.

Mr. Justice Romer understood that to be so.

Mr. Neville: If that be so, would that be a fair way of testing the defendants' process?—No; the results must be negative if those conditions were not fulfilled.

Cross-examined by Mr. Bousfield: Have you not, since 1891, been engaged in endeavouring to exploit the former knowledge of cyanide for your own benefit?—Undoubtedly I have. I wrote a letter to the papers to the effect that the matter had been thrashed out in Melbourne, and I was never more astonished in my life than when I knew that a patent had been granted for that.

Mr. Bousfield: As long ago as 1891 you were in the position of a partisan?

Mr. Justice Romer: He was anxious to prevent the monopoly.

Mr. Bousfield: He was not a disinterested scientific witness.

Mr. Justice Romer: That is most unfair. He seems to have given his evidence very fairly.

Mr. Bousfield put a number of other questions.

His Lordship again interposed.

Mr. Bousfield: I am only letting your Lordship know that he is not an independent scientific witness.

Mr. Justice Romer: You do not suggest that any expert comes forward from pure love of science, do you? At least, I do not.

Mr. Bousfield: He has a pecuniary interest in breaking down the patent.

Mr. Justice Romer: It might be retorted that experts for the other side also have an interest. Proceed.

Witness was then cross-examined on the criticism he had made of the experiment of the plaintiffs, with a view of showing that electricity did not help the solution. He repeated that the apparatus, in his view, was wholly ineffective for the purpose, because the two solutions were in communication. Witness was then cross-examined on the specifications of Rae, Sanders, and Simpson, but nothing of importance was elicited.

Mr. Robert Henry Harland, examined by Mr. Neville, said he was F.I.C. and F.C.S., &c, and had offices in Lombard Street. He had conducted a number of experiments in relation to the defendants' process, beginning with 2 lbs. of ore, going to 4 lbs., and ending with 25 lbs. In the case of the experiment with the electric current, the extraction of the gold amounted to 83·4 per cent., and in the cases of the solution without the current to 73·6 per cent., a difference of, roughly, 10 per cent. in favour of the experiment with the current.

Mr. Justice Romer: Was it the defendants' apparatus?—Yes, but not the one in Court.

Witness went on to say that he heard Mr. Tatlock's account of the way in which he worked. Witness worked by taking of a gallon of the liquor, evaporating it to dryness, and extracting the gold from it. The reason he adopted that plan was that it was impossible to get satisfactory results by assaying the tailings. He found it unsatisfactory because the difference of a few pennyweights in the assay of the tailings made all the difference as to whether the electric current assisted the solution of the gold or did not. It appeared to him that Mr. Tatlock's experiments were of no value to indicate the relative value of the two processes. The larger quantity of ore witness took led to more trustworthy results, as the gold in the crushed ore was never perfectly distributed throughout the bulk. Mr. Tatlock did nothing with the solution. Witness confirmed the evidence of Mr. Vautin as to the unsatisfactoriness of the tests for deciding the value of electricity.

In answer to His Lordship, Witness said that when baser metals were present in gold ore the weaker solution attacked the metals in the same order as the gold.

By Mr. Neville: If the solution had a greater affinity for gold than zinc, the zinc filter of the plaintiffs' apparatus would not work. He was also of opinion that Rae's method would be effective for the purpose of reducing the gold in the ore into solution.

The cross-examination of the witness was postponed until the following day, to meet his convenience.

Mr. Ed. Riley, F.C.S., &c., metallurgical chemist, said that it was known to him for many years before 1887 that cyanide of potassium was a solvent of gold.

In your opinion, was the exercise of any inventive faculty necessary to know that that was a solvent which would operate on gold in ores?—It was simply an application of a well-known chemical solvent under special conditions. I wish it to be distinctly understood that it would only apply to gold in a very fine state of division.

Mr. Justice Romer: Gold in the crushed ore?—In the crushed ore the gold exists in an exceedingly fine state of division; it is so fine that it will float on water, and it is just in that condition that a cyanide would dissolve.

Mr. Neville: Was it common knowledge at that date, in 1887, that this cyanide of potassium was available for the solution of gold and silver in ores?—Yes; it was used by the late Mr. Richard Smith for dissolving at the School of Mines.

Mr. Moulton objected.

Mr. Justice Romer: It can only be taken as part of the general knowledge; it cannot be put in as an anticipation.

Witness then confirmed the evidence of previous witnesses as to the solutions of Rae and Simpson dissolving gold.

Cross-examined by Mr. Moulton: Except in the case he had mentioned, prior to the MacArthur and Forrest patent, he never heard of cyanide of potassium being used practically to extract gold from ores. That cyanide of potassium was a solvent of gold was a broad chemical fact, and was scattered through all chemical literature. Faraday showed it, and so did Dixon's paper. It was not fair to assume that all Mr. Smith's knowledge and experiments were concentrated in Dr. Percy's book, though he carried out a great number of experiments for Dr. Percy's metallurgy. Witness learnt of Mr. Smith's experiments in the capacity of a personal friend. With regard to Rae, witness pointed out that the failure of Rae's patents was simply because he did not use the ore that was adapted to his treatment. Rae would have got the gold into solution probably, but it depended entirely on the current and the strength of the cyanide of potassium; he thought the latter would dissolve the gold, irrespective of the current.

Mr. James Mactear, F.C.S., F.I.C., F.I.M.&M., &c., a metallurgical chemist for 30 years, said that in 1887 the solvency of gold in cyanide of potassium was well-known, and no inventive faculty whatever would have been required to know that a solution of that substance would dissolve the gold in ore when pulverised.

Have you joined with Mr. Vautin and Mr. Harland in the experiments which have been applied to the question of whether gold dissolves or not more rapidly when exposed to the action of the electric current in the solution?—I have.

In your opinion, does it dissolve more rapidly when submitted to the influence of the current or not?—It proves what I had already believed by theoretical reasoning, that the gold dissolves more rapidly, and so does silver—silver the more rapidly of the two.

In 1887, was the process of applying cyanide of potassium to the solution of gold in ore when crushed likely to be a financial success?—No, it was impossible.

Why?—For two reasons. In the first place, the known methods of getting gold out of such a solution were exceedingly defective, and

publications to that effect are extant. The only method which was known of getting the gold completely was by absolutely destroying all the cyanide and melting the gold.

What do you say as to the cost of such a method as that?—Consequently, the whole of the cyanide would be destroyed.

What effect would that have on such a process as a commercial success?—It would make it an entire failure, owing to the exceedingly high cost of working.

Witness, in support of this view, gave the prices of cyanide to the Court. These showed that cyanide had come down in price from 18s. for pure cyanide to 1s. for the commercial article. In his opinion, for practical purposes, the inclusion of carbonate of ammonia in Simpson's mixture would not be injurious for the solution of gold out of ore. If commercial cyanide was used, carbonate of ammonium was invariably present in the plaintiffs' process. Witness then confirmed the opinion that Mr. Tatlock's experiments were not satisfactory for the purpose of comparing the results of the two processes with the current and without it. The gold was finely divided throughout the mass, and the sample was by no means homogeneous, and the result was, that the two assay samples taken from the same half pound of material would give an error of assay which, in his opinion, was sufficient to vitiate the whole experiment. In his opinion, Mr. Harland's method of testing the two processes was in every way better than that adopted by Mr. Tatlock.

Cross-examined by Mr. Moulton: The Witness gave counsel a number of extracts from scientific literature (not included in the particulars of objection) which, he claimed, expressed to the world that cyanide of potassium would, in the cold, dissolve gold at a practical rate. He agreed, generally, with Mr. Riley's evidence as to Rae's specification. He thought Rae imagined that he would facilitate his electrical operation by bringing the particles of gold in contact with his metallic anode. He did not disagree with the results of Lord Kelvin; but in the experiment as carried out by Lord Kelvin, the current was so small that the dissolving power was practically nothing; and, secondly, the apparatus was so constructed as to permit of a solution of gold with cyanide of potassium without the aid of electricity flowing into one of the cells, where, in all probability, part of it was deposed through the discs.

You say the difference is, first, that the current was too small?—One of them.

Next that the cyanide was not kept in motion?—Yes, being renewed.

And that there was some deposit from the other half of the trough?—Yes.

Did not the current appear to make the dissolving rather less than more?—No, I do not think these experiments show that.

You think that the current would produce no effect electrically, and that practically you may take both of them as being instances of the absence of electricity?—I do, practically so.

Witness said he had never seen the defendants' process at work. An ordinary chemist reading Simpson's specification would know that it was a failure, because you could not by zinc get the gold out of the solution profitably.

The Court then adjourned for the day.

Woodhouse & Rawson United, Limited.

Public Inquiry before Mr. Registrar Hood.

(*Continued from page* 104.)

The inquiry into the failure of this company was resumed on Friday, July 27th before Mr. Registrar Hood, at the London Bankruptcy Court.

Mr. F. L. RAWSON, the managing director, was again called and further examined by Mr. C. J. Stewart, the Official Receiver. Questioned as to the report of Mr. Pilling upon the Kidsgrove business attached to the balance-sheet of 1891, he said that he did not think this report came to his knowledge until after the winding up.

Mr. Stutchbury, recalled, said that there appeared to be no record in the minutes of the report having been laid before the board. The minutes were not always entered up in the terms in which he drew them, but were revised and amended by the chairman, Sir R. Rawson, and the managing director. He did not suggest that the minutes had been so altered that they did not fairly represent what took place at the board, but he could not say whether this was the case or not, unless he saw his draft minutes. He had asked to see these draft minutes, but had not been able to do so.

Mr. F. L. Rawson said that the receiver had informed him that he had sent the documents in question to the official liquidator.

The Witness continuing, said that his view was that the minutes should be entered in the form in which he drew them up, and that any alteration should be made at the next meeting of the board. With regard to the report of Mr. Pilling, he had no recollection of the report having been brought to the notice of the directors, although his impression was that it had been seen either by the board or the finance committee.

By the Registrar: He could not suggest any reason why, if the report was laid before the board, there was no reference to it in the minutes.

By Mr. Pilling: He saw the report, showing that a loss of £8,000 had been made on the Kidsgrove business during the first year.

Mr. F. L. Rawson, continuing his evidence, said that Mr. Pilling, in his report, called attention to the fact that book debts to the amount of £4,600 remained uncollected, that £4,322 was owing to a firm in respect of advances made, and that £2,640 of the profit shown represented increased value put upon the stock and plant at Kidsgrove. It was true that in the balance-sheet of 1892 a sum of £17,000 was written off as loss on the Kidsgrove business, but in 1891 he had no reason to suspect that any of the book debts were bad. The greater part of the loss incurred in 1892 was due to losses on contracts taken over from the vendors. The stock and plant at Kidsgrove were re-valued in 1891, and it was then found that it was worth considerably more than the amount at which it was estimated by the vendors. It appeared that the latter had purchased additional stock which did not appear in their books at the time of the sale, and that they consequently parted with their stock and plant at less than its real value. He did not think the fact that, in Mr. Pilling's opinion, a loss of £11,000 had been made in October, 1891, was reported to the directors. He (witness) was aware that a loss had been made, but he could not say that he knew at the time that the loss amounted to £8,000 or £11,000. In the report issued to the shareholders in November, 1891, no reference was made to the losses at Kidsgrove; but, in his opinion, anyone accustomed to reading such reports would infer that there had been losses, from the absence of any allusion to profits. The founders' shares in the Phœnix Trust had been acquired by the United Company for £25. In the balance-sheet for 1891 these were valued at nearly £15,000. A dividend of between £5,000 and £10,000 had been received during that year from those shares, and it was expected that there would be another distribution of something like the same amount within a few months. The £15,000 represented entirely Elmore securities. He did not think the estimate was at all too "rosy," and he still believed that the shares would turn out quite as valuable as had been anticipated. A sum of £5,000 was paid by the Phœnix Trust Company as the profit of the United Company on the formation of the Austro-Hungarian Elmore Company. In the following year, owing to the difficulties of the Elmore Companies, the valuation of these shares was reduced to £9,000, and when the Phœnix Company wound up, the amount they received was £12,000 in shares of the American Elmore Company. In the balance-sheet for 1892, the loss on trading and depreciation of stock and businesses was returned at £69,531. Baron Grant had no connection with the Mexem (?) Works, Limited, which was promoted by the United Company. With regard to the value put upon the shares, the practice was to take the Stock Exchange quotation in all cases in which there was one. In cases in which there was no quotation, the value was estimated as nearly as possible, and the price was carefully verified by the directors. In the case of the Epstein patents, the directors had Mr. Epstein twice up before the board and examined him as to the position of the company and its prospects, and also as to the negotiations which were proceeding with regard to the sale of the foreign patents. The opinion of the late Mr. Reckenzaun was also taken with regard to the patents. As to the Phœnix Trust founders' shares, the valuation was based upon the amount which witness and the directors considered would be divisible if the company had at that time wound up.

Mr. H. G. Rawson asked leave to recall certain of the directors with a view to obtaining their evidence as to the date at which they first became aware of Mr. F. L. Rawson's connection with the Phœnix Trust.

His Honour assenting,

Mr. Philip Rawson again went into the box. He said that he was present at the meeting in September, 1890, at which the managing director made a statement to the board as to the matter in question, but he could not remember that the fact of Mr. F. L. Rawson's holding founders' shares in the trust was then mentioned. He had no knowledge that Baron Grant was connected with the Trust and held 1,000 shares in it, and that the remainder were held by the managing director, his wife, and the National Financial Corporation.

Mr. Stewart: If you had known these facts, would they have affected your judgment in dealing with the Trust.

Witness: They would, but I cannot say to what extent.

By Mr. F. L. Rawson: His impression was that he knew of the managing director's connection with the Trust in February, 1891, but he could not say whether the fact of his holding founders' shares was then mentioned.

Sir John Stokes, recalled, stated that he was not present at the meeting in October, 1890, and could not say when he first became aware of the managing director's interest in the Trust. To the best of his recollection, he was not informed of all the circumstances attending the formation of the Trust or of the distribution of the shares.

Mr. F. L. Rawson, continuing his evidence, denied that the reason for extending the financial year of 1891 was to enable the assumed profit on the Epstein shares to be included in the accounts for that year. That course was taken at the suggestion of the auditors to enable the accounts from the out-lying businesses to be all taken at the same time. As a matter of fact, the contract with Mr. Epstein could have been concluded earlier, but the matter was delayed at witness's request to enable him to obtain more advantageous terms, which he actually did. The board were advised by counsel as to the propriety of including the Epstein profits in the accounts, and the counsel referred to was so satisfied as to the nature of the profits and the prospects of the company, that he himself accepted a seat on its board. The whole of the facts with regard to the patents were most carefully gone into by the board; not once, only, but at many sittings, which lasted several hours at a time. In his opinion, but for the stingy manner in which the United Company "dribbled out" its assistance to the Epstein, the matter would have been a success.

Mr. Stewart: It has "dribbled out" to the extent of £13,000.

Mr. Rawson said that £4,000 was advanced before the Epstein Company was formed, and the remainder was paid at intervals during 1891 and 1892. The item "cheques and cash in hand" appearing in the balance-sheet of June, 1890, included a cheque for £31,000 given by the International Okonite Company. The cheque was not paid into the bank for two or three days afterwards, and was then duly honoured. It had been agreed to hold the cheque over at the time when it was given.

In answer to Mr. Squires, a shareholder and member of the committee of inspection, the Witness said that the profit of £37,235, estimated on the promotion of the Okonite Company, was not brought into the books until about two months after the close of the financial year. The directors were advised by counsel that it was an item which could properly be brought into the balance-sheet of June, 1890. It was true that the prospectus of the Okonite had not been issued at that time, but it was a recognised rule that the profit on a contract should be credited at the date on which the contract was entered into. He did not think it was a little "previous" to bring the item into the accounts of June, 1890, and there was no special reason for doing so. It was true that his (Mr. Rawson's) commission on the transaction amounted to £9,368, but he informed the directors that as the profit was partly payable in shares and debentures, he was quite willing either to wait until these were realised, or to receive his remuneration in any of the shares and debentures at the price at which they stood in the balance-sheet, and it was arranged that his commission should stand over. In 1891 the shares were written down to the price at which they then stood on the Stock Exchange. He was present at the general meeting held on December 22nd, 1892. As a director of the Phœnix Trust he was aware at that date that the company was going into liquidation.

Mr. Stewart: I see that the resolution for winding up was passed on the day following the general meeting.

The Witness explained that the Trust had carried out the business for which it was formed; that it then divided its assets, and wound up. Questioned as to the formation of the Trust, Mr. Rawson said that prior to September, 1890, negotiations were carried on with a view to the flotation of the Elmore shares held by the United Company. These negotiations were reported by him to the directors, and he advised them that something more than par ought to be obtained for the shares. A syndicate was eventually formed, which he (witness) hoped would carry through the financial business which the United Company had always refused to do.

Mr. Squires: They seem to have done a fair amount, notwithstanding.

The Witness added that the persons composing the syndicate afterwards "backed out," and to prevent the matter falling through he got his wife to take 1,000 shares, and he himself took the same number. The amount actually paid up was, perhaps, not more than £1,200, but shares for £20,000 were subscribed for and allotted. His wife and he were liable for £5,000 each, and he also lent the company £5,000 the day after its formation. The United Company received about £6,000 as profit on their 25 founders' shares, and he (witness) received about the same amount; but, on the other hand, he had not been repaid the £5,000 which he advanced. He did not press his claim at the winding-up, as he wished the United Company to get all they could. There might have been some writs out against the company in January, 1893, but he certainly considered that the company had "credit and reputation to lose" at that date. The best proof of this was that they were able to get goods supplied, and that he (witness) and his father had sufficient confidence in the prospects of the company to give guarantees to enable it to carry on. He (witness) had made himself personally liable for £10,000 on such guarantees during the period in which the committee were preparing their report.

The examination was then adjourned to Friday, August 3rd.

Edison-Bell Phonograph Company *v.* Hough.

In this action Mr. Fletcher Moulton, Q.C., on Saturday asked Mr. Justice Stirling, sitting in the Chancery Division of Justice, to grant an interim injunction against Mr. J. B. Hough, trading as the London Phonograph Company, restraining him from infringing letters patent of the plaintiffs, No. 6,027, and dated May, 1886, for improvements in the phonograph.

The phonograph, as invented by Mr. Edison, the learned counsel said, was an instrument which reproduced an exceedingly few consonants, and the vowels so badly that they were hardly to be recognised. He proceeded to say that this original machine consisted of a layer of tinfoil placed on a cylinder with a point connected with the diaphragm which, by pressure, made greater or smaller indentations in the tinfoil. Though an exceedingly imperfect instrument as thus first brought out, it was of great interest in acoustics, as demonstrating a purely mechanical means of reproducing articulate sounds. For some time no progress was made towards perfecting it, until the invention of a wax cylinder, on which not merely indentations were made, but the substance was cut out by means of a knife fixed to the diaphragm which removed portions of the hardened wax. That was the one step towards making a perfect phonograph, and these machines were now used by, he supposed, hundreds of houses for business purposes, it being possible for a message or letter to be read off by a clerk, thus making the instrument of practical value. The letters patent in respect to this improvement had been sued upon by the company, the defendant being one John Lewis Young, in the Queen's Bench Division, where the plaintiffs were successful, and Young going to the Court of Appeal his appeal was dismissed with costs. He was also sued in the Chancery Division on these letters patent, and in his defence set up every possible objection, but the case coming on for trial at the last moment, and without the slightest arrangement with the plaintiffs, he simply did not appear to defend the case, and the plaintiffs obtained judgment. In that case the validity of the letters patent did not come up; but in another case it did, and the validity was certified by the judge for the purposes of the Patent Act. So that they had defended the old patent, which they had held since 1886, for eight years, and they could not, of course, be expected to go to the expense of bringing actions, and after carrying them to trial, being, through the impecuniosity of the defendant, deprived of the benefit of the proceedings further than establishing the validity of the patent. The defendant fought the company with the greatest possible tenacity, and no sort of arrangement was made with him to obtain the judgment, declaring the validity of the patent and establishing the infringement. In these circumstances he submitted to his Lordship, with great confidence, that plaintiffs had established a right at law, and were entitled to the interim injunction he asked, and not merely to an order to defendant to keep account, because he thought he should be able to show he could not resist the charge of infringement, he having in cross-examination in an action against him on other letters patent, in which plaintiffs obtained judgment, admitted that he had infringed this particular patent. If he established these facts by his affidavits, as he hoped to do, he should confidently ask for the interim injunction, nothing less than this being likely to be of practical use to the plaintiffs. The fact was these instruments got into the hands of impecunious persons, and when judgments were obtained against them, they disappeared, and plaintiffs could neither trace them nor get damages from them. They use practically the same instruments as those covered by the plaintiff's patent, and made under it in America. The American patent, however, did not belong to the English company, though they had a clear title to the whole of the English patent, and the instruments were, without controversy, the same. His Lordship, he thought, would without hesitancy, grant the interim injunction as asked, on remembering that if defendants were not restrained it was absolutely certain that if plaintiffs succeeded at the trial—of which really he had no moral doubt—the plaintiffs would be unable to get a single penny in damages from him.

The learned counsel was about to read the affidavits in support of his case when the hour for the rising of the court having already been reached, his Lordship adjourned the further hearing until Tuesday, Mr. Terrell, for the defendant, saying there was a good deal in the Young proceedings which he should ask his Lordship to rule out in the present case.

When the hearing was resumed on Tuesday, Mr. Terrell read an affidavit for the defendant, in which it was stated that he had been for a long time exhibiting and using the phonograph at exhibitions in Edinburgh, Glasgow, and at other places in Scotland, as well as in England.

An affidavit in reply, by Mr. David L. Henry, manager of the plaintiff company, at Edison House, Northumberland Avenue, was also read, in which he stated that the same objections to the validity of the letters patent were raised in the action against Mr. Young, in which Mr. Justice Romer delivered judgment on June 15th last. The plaintiffs were aware before December, 1893, that there were many infringements of their patents by persons of no substance, and therefore they decided to proceed against Young, who was the most substantial infringer.

Mr. Moulton, Q.C., then addressed the Court for the plaintiffs. He said that the question was this. The plaintiffs had done everything in Young's case to establish their right at law in this patent, and at the last moment the defendant had run away.

Mr. Justice Stirling: Is that establishment of the patent in law?

Mr. Moulton replied that certainly it was. Formerly, a plaintiff was unable to get an injunction at law, and they used to apply in Chancery, and the Court stayed proceedings if the patent had not been established at law until he had established his right at law. It did not arise on statute at all, but on that custom of the Chancery Court. Then the plaintiff brought an action, and if he succeeded in that action he came back to Chancery and said he had established his right at law.

Mr. Justice Stirling: Against that particular defendant.

Mr. Moulton said Yes; but it then became the practice of this Court to grant interim injunction against infringement of the patent because it had been established at law.

Mr. Justice Stirling: When it had not been fought out?

Mr. Moulton replied Yes, when it was not the plaintiffs' fault that it had not been fought out. What was the plaintiff to do? It was thought oppressive if a patentee brought 80 or 90 actions on the same patent; and yet if they were not able to get an interin injunction and stop the infringers, they might just as well for months have no patent at all. It was well known that there had been a long series of phonograph patents, showing improvements bit by bit, until it had come to be the perfected and practical instrument which it was now. Respectable people did not infringe these patents. But if the owner of the patent had to wait until a person was found who would fight out with him the validity of the patent, he might have a long time to wait, and all the time the profits were being taken by the infringers, without the possibility of the patentee getting at them. It was not as if the company did not grant licenses.

Mr. Justice Stirling: What is the normal charge for a license?

Mr. Moulton said he was not sure, but £25 a year was the rent of these machines. They were very profitable, and there was evidence in one case of a man taking £5 a day from one of them, so that £25 a year was not at all prohibitory. On the other hand, if there were hundreds of people who could defy the corporation until the trial, then the whole of the profits could be taken away, so far as these exhibitions—which were the most profitable—were concerned. In Young's case the opposition was hostile to the very last, and the corporation obtained judgment with costs, so that the Judge must have been satisfied with the case for the validity of the patent. In these circumstances, he submitted that the corporation had established their right at law, and unless these interim injunctions were granted the corporation could not avoid suffering serious loss. The corporation had raised two actions—one against Young, the other against Lomax. The latter was stayed pending the result of the former; but an order had since been made that as the action against

Young was not fought out, Lomax was at liberty to fight. But that action could not come on for six months.

Mr. Terrell said that was plaintiffs' fault, because they had not sent in their answers.

Mr. Moulton replied that that was in consequence of the action having been stayed.

Mr. Terrell said he was authorised to say that his client would take every step the Court might suggest to expedite the action.

Mr. Justice Stirling asked Mr. Moulton why the present defendant was to be put in a worse position than Lomax, who had been attacked, but who had got leave to go on, no interim injunction having been made against him.

Mr. Moulton replied that when they sued Lomax, it was at the same time as they attacked Young, and when they had not established their right at law. But one having run away without standing fire, he submitted that the Court should protect the plaintiffs until they could get some one who would be screwed up to fight the case out. Young had been chosen as likely to fight most strenuously, and he did so, and he did so till almost the last. He (Mr. Moulton) was prepared to offer this, though not by way of compromise with the present defendant, that if the Court now gave interim injunction, the corporation would give the defendant a licence on the ordinary terms.

Mr. Terrell, for the defendant, said that the plaintiffs supreme difficulty was their delay in instituting proceedings. The plaintiffs said they had brought a large number of actions, but if so, it was very odd that they had never got an interim injunction. This was the first they had really struggled to obtain.

Mr. Justice Stirling said that if the defendant was only using two of these instruments, and the license was the moderate sum which Mr. Moulton mentioned, why should the defendant not bring that moderate sum into Court?

Mr. Terrell said that from the day that it was arranged that the action against Lomax was to go on, the plaintiffs had never delivered any reply.

Mr. Moulton said that was because negotiations had been going on with Lomax.

After a discussion as to the delay in bringing this action,

Mr. Justice Stirling asked Mr. Terrell what he said to taking a license.

Mr. Terrell said if it were not taken as an admission, he would pay something into Court.

Mr. Moulton said it was £25 for a machine, and it was not unfair to make the terms of a license according to the number of machines—so much for each machine.

Mr. Terrell said he was not prepared to do anything which would admit the plaintiffs' right.

Mr. Justice Stirling: Certainly not. It would be entirely without prejudice to any question.

Mr. Terrell said that as a proof of good faith he would bring £25 into Court, and it did not matter whether it was as a license or not.

Mr. Moulton: Very well; £25 for each machine.

Mr. Terrell: No.

Mr. Justice Stirling said he would not put it on the defendant to bring in £25 for each machine. In all the circumstances of the case, having regard to what had taken place, to the action against Young, to the fact that the action against Lomax had been allowed to proceed, to the fact that the present alleged infringement was known to the plaintiffs as far back as December last, and no interim injunction had been granted, he thought he ought not to grant an injunction on the present application. At the same time he was desirous to meet, as far as might be, the point made by the plaintiffs, that they had difficulty in dealing with a number of small infringers. He thought, after what he had heard, that the defendants' offer to pay £25 into Court was a fair offer. Upon payment of that sum into Court, and upon terms that the action was prosecuted without delay, and that the pleadings should be delivered during the vacation, and giving leave—as soon as the pleadings were completed—to either party to apply to expedite the trial, there ought to be no injunction, the defendants, however, to keep the usual account.

On these terms the motion for an interim injunction was refused.

Smith *v.* Immisch Electric Launch Company.

His Honour Judge Vernon Lushington and a jury were engaged on Tuesday at Kingston-on-Thames County Court hearing an action brought by Mr. Thomas Smith, tile fixer, of Fulham, against the Immisch Electric Launch Company, Limited, the plaintiff claiming from the defendants the sum of £48 3s. 6d. for losses and injuries sustained in a collision on the Thames at Hampton on Whit Monday. From the evidence of a large number of witnesses for the plaintiff, it appeared that on the day in question he got into the Hampton ferry boat, along with ten other men, to proceed to the Middlesex shore. The boat was a large one, capable of accommodating several more passengers, all of whom were seated in the stern. About 30 yards from the Surrey shore one of the defendant company's electric launches was seen approaching from the direction of Molesey Lock. There was another launch and a small boat in front of the ferry, so that it had to stop, and as the electric launch was running down on the ferry, Langshaw, who was in charge, shouted out to the captain to stop or to pass on his stern. The captain, who was alleged to be talking to a boy at the time, did not appear to hear the warning, and seeing that a collision was inevitable, Langshaw shouted to the passengers to keep their seats, and taking the sculls tried to turn the ferry round so as to break the force of the blow. The next moment the launch struck the ferry and capsised her. Plaintiff went right under the launch at the bow, and came to the surface at the stern, where he was rescued and taken on board, much knocked about and completely exhausted. As a result of this he had been laid up for five weeks. For the defence it was urged that the accident was wholly due to the carelessness of the ferryman, who backed instead of pulling forward. The jury, however, found for the plaintiff, and awarded him £10 damages.

CORRESPONDENCE.

Consulting Engineers.

In a recent issue of your journal you devoted considerable space to an article upon a subject which cannot fail to appeal most strongly to all *bonâ fide* consulting engineers.

You published some months ago a very forcible article entitled, "What is a Consulting Engineer?" and you have also from time to time drawn attention to singular instances, such as the Coventry incident.

I am a little surprised that your consistent crusade against the abuses of the title "consulting engineer" has evoked so little comment from the profession. Can it really be true, as was recently asserted to me, that the *bonâ fide* consulting engineers in Westminster could be counted upon the fingers of one hand? I am loath to think this, and yet, I repeat, it is unaccountable that no definite action has been even proposed in the quarters to which one would naturally look for a remedy to so crying an evil. In every other profession, worthy the name, the public is protected against quackery and misrepresentation of qualifications. A man practising as a doctor or a lawyer, or representing himself to be a clergyman, without having first obtained the necessary qualifications, is subjected to a legal penalty. It is open to the engineer only—or, I should say, to any member of the public—to put the mystic letters C.E. after his name in order to pose as a member of what is undoubtedly a most honourable profession.

I think that the time has come, aye, indeed, long since gone, to distinguish between the false and true consulting engineer and to protect the public against the results of misplacing their confidence through no fault of their own. I suggest that it is for the Institution of Civil Engineers, possessing, as they do, a charter, to introduce some system whereby only duly qualified engineers should be recognised as such, and to issue some regulations, or to confer some form of diploma or distinctive title upon those men who elect to follow the purely professional side of engineering. It is of no use to blink at the fact that the consulting engineer, whose only remuneration is the amount of his fee paid to him by his clients, is in a very minute minority; and, moreover, those who act up to their profession as consulting engineers never get the credit of doing so, and if by any chance circumstances should prove beyond doubt that a consulting engineer has acted in such wise in any matter, he is looked upon as a man of quixotic tendency, tilting at windmills in a corrupt world, who will learn better sense (*sic*) as time goes on and he gains experience.

I should suggest that those engineers who wish to enrol themselves as purely professional men should send their names, in confidence, to Mr. James Forrest. I feel quite certain, from my personal knowledge of that gentleman, that he would always be ready and willing to lend his valuable assistance to any scheme having for its object the advancement of the engineering profession.

Consulting Engineer.

Ship Wiring.

In the Electrical Review of July 13th, pages 26 and 27, you say, having recently had various discussions on ship wiring in your columns, not a single reference was made to the general use of the distributing system, which statement I consider incorrect.

See pages 179, 272, 308, 397 of this year's Electrical Review, and you will find that I continuously mention this very system and recommend its use. Hoping that you will recall this statement, I shall be pleased to see the distributing system universally adopted.

Leon H. Cline.

July 28th, 1894.

Alternate Current Distribution.

Referring to the *pro forma* balance-sheet of averages of 29 central lighting stations I sent you last week, I notice that a type-written error has crept in, viz.:—"Units to the £ capital = 1·00," should read 3·46. As this is a most important item, I think it well to correct it at once.

Alfred Thompson.

July 30th, 1894.

NOTES.

Progress at Dewsbury.—It is confidently expected that the electric supply will be ready this month.

The Cost of Current at Sunderland.—It is proposed to fix the price per unit at 6d.

Church Lighting.—Leeds Parish Church is to be lighted by electricity.

St. Helens Appoint an Engineer.—Mr. Robert Hammond has been asked to prepare a report on the electric lighting of the borough.

French Atlantic Cable Project.—In a brochure lately published by M. P. Bordonnaut, a direct cable between France and her West Indian possessions is advocated. M. Bardonnaut (late chief engineer of French Government telegraphs) gives estimates of the cost of this work, and is satisfied that a considerable reduction may be effected on the present rate for telegrams to the West Indies. From the French point of view such a cable will be useful, not only as furnishing direct communication with the West Indian Islands, but also as assisting the French company, which already has a network of cables amongst these islands, extending as far south as Brazil.

Worcester Electrical Exhibition.—The Corporation of Worcester have arranged to hold a popular Exhibition of Electrical Appliances in October, at the time of the opening of their electric lighting works. A great deal of interest is being shown locally at the steps taken by the Corporation for providing the city with electric light, and it is hoped that such an Exhibition will show what can be done with electricity, and help to attract consumers. Already orders for over 3,000 lamps have been received by a local firm. The Corporation intend using the current for street lighting, and also for driving some of the pumping machinery at their waterworks.

The Medical Battery Company, Limited.—The following note appeared in last week's *Lancet*, the significance of which cannot be misunderstood:—"On Wednesday last the Medical Battery Company, Limited, with which in more than one relation we deal this week in a leading article, received sanction from Mr. Justice Vaughan Williams to a scheme of reconstitution. The learned judge said that he must be satisfied that the business to be carried on was proper, and only sanctioned the scheme on the understanding that the electrical treatment and the sale of electrical belts should be controlled by a duly qualified medical man. This sanction runs a risk of being of no practical worth. The General Medical Council, knowing more things medically, will require more intimate satisfaction than his Lordship as to the propriety of the Medical Battery Company, Limited, as a business, and the probable result will be that any duly qualified medical controller would cease to be duly qualified as a result of his appointment. Which is a *reductio ad absurdum*."

Gas v. Electricity.—Says the journal of *Gas Lighting*:—"Our contemporary, the Electrical Review, in commenting upon the Blackfriars accident, credits the company with having taken every conceivable precaution to guard against such risks by providing guard rails for the live mains, which, if in place, would constitute a sufficient protection. Unhappily, in the case in point, this protection was left aside 'in a moment of forgetfulness, and the awful and tragic penalty was paid.' Just so. There will and must be, while human nature remains as it is, these moments of forgetfulness; and it is none the less terrible that a bar of metal, which is capable of safely conveying a heavy charge of electricity, such as would kill a man who should inadvertently touch it, does not exhibit any warning to the senses of its death-dealing capacities." To this we will also reply, just so; but why refrain from alluding to the innumerable cases of death from suffocation, explosions, &c., caused by gas, which has *sometimes* the capacity of making its presence known, but in a manner which oftentimes leads to the very disasters we would wish to avoid.

Brasyer v. Harness.—We commend to the notice of our readers the very excellent and forcible leader on this trial contained in the *Lancet* of the 28th ult. It may not be generally known that as far back as January, 1889, it was pointed out in the leading organ of the healing persuasion that the Medical Battery Company, Limited, or Electropathic and Zander Institute, was not a respectable professional institution, and was not conducted by persons of recognised standing in the medical profession. For this expression of opinion the company brought an action against the *Lancet*, and claimed £5,000 damages for libel. That action was, however, discontinued by the company, which had to pay the defendant's costs.

The New Atlantic Cable.—We understand that the ss. *Scotia* and *Britannia*, belonging to the Telegraph Construction and Maintenance Company, have arrived in the Thames, having completed the laying of the New Atlantic cable for the Anglo-American Telegraph Company. It appears that on July 9th the *Scotia* ran into an iceberg during a fog, somewhere to the north of the Newfoundland Banks, and was fortunate enough to sustain no further damage than the breaking of her bow girders. As the class of cable adopted by the Anglo-American Company on this occasion is altogether different from any of which they have had previous experience, we hope that it was laid "without a hitch," and that the tests are quite satisfactory.

Damages for Electrical Shock.—We read in an American exchange that in March last, while two men were taking a constitutional in Innsbruck, they discovered a telephone wire hanging down to the ground, when one of them picked it up and promptly yelled for assistance. His friend came to the rescue, knocked the wire out of his hand with a stick, and received a shock which rendered him unconscious. On recovering, he found that the picker up of unconsidered trifles was dead. A court of inquiry has now been held, at which three of the officials of the local electric lighting company were charged with culpable negligence. It appears that they had been warned several times that telephone wires above their conductors were broken, but no attention had been paid to the matter. The telephone wire in question had fallen across the conductor, resulting in the accident. One of the officials has been sentenced to one month's imprisonment, the second to four months' imprisonment, and the third has been discharged. In addition, an indemnity of 100 florins has to be paid to the injured man. Nothing has been awarded to the relatives of the dead man. It therefore appears that in Innsbruck it is less expensive to kill a man than simply to knock him down.

Lecture.—The Public Health Congress was treated early this week to Mr. Binswanger's views on "Electric Power, Heating, and Lighting." This is a subject on which it would be very difficult to say anything fresh, even from its hygienic aspect. When, however, the paper was found to consist largely of definitions of electrical units and elementary descriptions of the actions of motors, we wonder whether the sanitary reformers fully appreciated what they heard. The opinions expressed as to the advantages of electricity in aiding domestic hygiene were fairly well put, and suited the audience. At the same time, a little regard for the accuracy of scientific language would have added to the beauty, if not to the utility of the paper, which otherwise was interesting and instructive to the health reformers. "Constant current" was used as the opposite of "alternating current." Surely this term has now come to have only the one meaning of a current at a fixed number of ampères, and not indicative at all of a uni-directional current. It is the current that is constant in a "constant current," and not its phase. Then in talking of lighting, we are told that the "heat in the arc is the most intense that can be obtained by the ingenuity of man." Heat alone indicates quantity of heat measured in thermal units; temperature is what is here meant. There are one or two other lapses which might be cited, but we have no wish to be supercilious in this matter. But it must be remembered that even municipal and sanitary engineers are trained in a school of exactitude, and any failing on the part of an electrical engineer who, by proferring a paper, takes the stand of an expert, is bound to be detrimental to his class as a whole.

The Crystal Palace Electric Light Company a Nuisance.—"By reason of the company causing effluvia, smoke, and noxious vapours to issue from a chimney shaft which causes nausea," it is to be prosecuted by the Lewisham Local Board.

Electricity at the East-End Docks.—It is satisfactory to note that the Chairman of the East and West India Dock Company says that, after spending £12,000 upon a new electric light installation, it had resulted in a saving, during six months, of £1,000.

Denbigh and Electricity.—Owing partly to a disagreement with the gas company, the Town Council are considering the introduction of electricity. When gas consumers and gas companies fall out we know the rest.

The Government and the Telephones.—Mr. Arnold Morley, the Postmaster-General, has given an undertaking that an opportunity shall be given for discussing in the House of Commons the agreement between the Post Office and the National Telephone Company.

The Bristol Electric Tramway.—A Bristol paper states that the preparations for the construction of the electric tramway to St. George and Kingswood are so well advanced, in anticipation of the Bill passing, that the Tramway Company hope to open the line by the middle of next month.

Much Ado About Nothing.—Messrs. Henry F. Joel and Co. have written to the *Stratford Express* complaining that the contract for lighting the Canning Town Free Library and Public Hall has been given to the Brush Electric Light Company, whereas they consider it ought to have been secured by themselves, because their quotation was £64 lower than the Brush. The estimates, however, which we give in another column, show a difference of less than £20. The Brush Company being well known was recommended for acceptance, at least, this is the reason given to Messrs. Joel and Co. These latter state that they are also well known and respected in the trade, and then go on to give the qualifications they possess as a proof of their capability for carrying out the work. But if the tenders were sent in on the understanding, which is almost universal, that the committee did not bind themselves to accept the lowest or any tender, we fail to see the force of the outcry raised by Messrs. Joel & Co. Better by far stick to giving remunerative reports on electropathic belts and generating body currents of extraordinary voltage. In this domain of electrotechnics the firm will meet with no competition.

Japanese Cables.—The conflicting, though scanty reports, concerning the warlike proceedings in Japan and the Corea, may be attributed to the fact that cable communication with Japan is interrupted; whether this interruption is caused by the official closing of the telegraph offices, or by the still more summary method of cutting the cables, we cannot say. It is certain, however, that neither Chinese nor Japanese would have the slightest difficulty in destroying these cables, as the cables from Shanghai to Nagasaki run in water less than 50 fathoms deep for 200 miles from Shanghai; and the Nagasaki-Vladivostock cables, for nearly the same distance, lie in water under 100 fathoms deep. As we have frequently pointed out, it is impossible to count on these cables in the Eastern seas for immunity from interruption. The cables of the Eastern Extension Company, which at present are the only means of communication with China, could be picked up easily, and without any very special appliances. The cable recently laid between Singapore and Hong Kong, touching at Labuan, lies for about 600 or 700 miles in water not exceeding 40 fathoms in depth. Communication with Australasia is altogether dependent on cables, which in the Java Sea and the Straits of Malacca, run for about 1,000 miles in water nowhere deeper than 40 fathoms, and averaging about 25 fathoms, and which are therefore completely at the mercy of any craft which happens to have an anchor to drag across these lines. We do not enlarge on the ease with which the cables to India could be cut, either in the Gulf of Suez or at the entrance to the Red Sea, where, if we except landlines, the shallow water (under 40 fathoms) leaves our communication with India, Australasia, and China, altogether in the power of any hostile vessel.

The Electric Light Departs from Holywell.—A local paper says: "The electric light which has occasionally shed its refulgent rays on the public from the front of Miss Whitehouse's shop came to an unexpected end on Wednesday morning, when without warning the apparatus broke from the chain which held it, and fell into the street beneath."

The Manchester Meeting of the Mechanical Engineers.—The other paper of interest to electrical engineers read at the Manchester meeting, besides the one published in this issue, was one on the Manchester Station, communicated by Dr. John Hopkinson. A full description of this station appeared in the Electrical Review a fortnight ago.

The True Ohm.—In view of the legalising of the true ohm by the Board of Trade, it may not be amiss to point out that the ordinary forms of Wheatstone bridge can be made to measure to true ohms by the simple expedient of readjusting the coils in one of the ratio arms, so that these coils, instead of having equal values, have values in the proportion of the B.A. to the true ohm. It is true that this arrangement does not admit of the ratios being reversed, but there are many cases in which a bridge is solely used for measuring low resistances, so that the necessity of having to reverse does not occur.

The Boynton High Speed Electric Railway System.—An electric railway, on whatever system it is constructed, must do three things. It must compete with its opponents, pay a handsome income to its owners, and thoroughly satisfy its patrons. One of the most promising of the systems which have been experimented upon in the United States is a combination of the bicycle and the trolley, with a flavouring of what we know in this country under the style of telpherage. In this case, however, the rope way of the latter is displaced by a light channel iron structure. By this combination rapid transit is easily realised. From what we have heard from a gentleman who is fully acquainted with the experimental trials and present position of this system in America, there seems to be no reason to doubt that the details incidental to success have been fully worked out, and that the system is actually at work on a commercial scale, with most encouraging results. The particulars have been placed before some leading traction authorities in this country, and negotiations are practically completed for the system being taken up and pushed here. One of the leading firms of electrical engineers in London is also carefully investigating the subject, and seems disposed to adopt it for contracts about to be tendered for. On the railroad in question a narrow car with sharpened ends is employed, mounted on two wheels, one at each end, travelling upon a single rail. It has the equilibrium of the bicycle, and like the latter, disposes at once of the violent lateral wrenching strains which affect four-wheeled vehicles of the usual type. The rails being placed in a vertical plane instead of in the horizontal, the upper provides a place for the current main where it is unobjectionable. Each of the bearing wheels is journalled in a frame at the bottom of a vertical shaft rising through the car roof. The upper end of this column carries a frame with four guide wheels which have vertical axes, and between which there is space for the upper guide rail. The car body swings on springs attached to the two columns. As these are fastened near the roof of the car, the body can spring up and down without affecting the columns and wheels. The wheels form part of Gramme motors, each of which is designed to give 75 H.P. The current rail is 1¼ square inch in section, weighing 12 lbs. to the yard. A railway on this principle is now running across Long Island, U.S.A., from Bellport to the Sound, being equipped with a 4-pole 100 H.P. Westinghouse generating plant. A car seating 24 people would weigh 6 tons fitted with motor complete; a trailing car to seat 50 would only weigh half this amount. These cars are 51 feet long by 4 feet wide and 7 feet high. A train of two motor cars and three trailers, accommodating 200 people, can be built not to weigh more than 20 tons. The radius of the maximum curve on the present line is only 640 feet. We hope to deal with this system more fully in an early issue, as it seems to contain devices of some importance, while the principle is what experience would indicate as being a correct one.

More Light.—The voice of the St. Pancras Ratepayer: "No thank you, we have gone in for one luxury in the way of enlightenment, but a Free Library would be a little too much."

Electric Light at Bridlington.—The North Cliffe, Bridlington, a much frequented part during holiday time, was lighted for the first time last week.

The Lancaster Electrical Engineer.—It has been decided to increase the salary of Mr. Barnard, the borough electrical engineer.

Winchester Advances.—The Winchester Town Council has at last decided to apply for a provisional order. It is expected that the works will cost £20,000.

Disappointing Reports.—The following is from the *Bullionist* of the 21st ult. "We had prepared our readers for the issue of disappointing reports for the past half-year by the Atlantic telegraph companies, and the accounts just issued by the Direct United States Cable Company prove how correct was our forecast. In the document before us we are told that the company earned in the six months £34,843, as compared with £40,836 for the corresponding period of 1893. The working expenses were £18,750, as against £18,898 in the same six months of last year, which seems to indicate pretty clearly that the expenses of a company earning its dividends from the operation of an oceanic telegraph line are much the same in bad as in good times. Altogether the shareholders get 2⅝ per cent. in dividends for the year on their £20 shares; but as these are only quoted at about £8½, we should not counsel holders to rush and throw them on the market, especially as we learn from excellent authority that it is hoped that the company will presently benefit by the expected revival of trade, which has been so long looked for, and so long delayed. Sir John Pender himself recently attributed the falling off in the earnings of the telegraph company to the world-wide depression in trade alone, and it is only reasonable to expect that when this is succeeded by a revival in general business, we shall find the telegraph companies paying more respectable dividends than they been lately doing."

NEW COMPANY REGISTERED.

Wray Electrical Engineering Company, Limited (41,634).—This company was registered on the 21st ult., with a capital of £10,000, in £1 shares, to enter into a certain agreement for the acquisition of the business of the Wray Electrical Engineering Company, carried on at Bradford, Yorkshire, and to carry on the business of electrical and mechanical engineers, engine makers, model makers, &c. The subscribers (with one share) are:—C. Wray, 6, Cornwall Terrace, Bradford, electrical engineer; J. G. Jessop, Masham House, Bradford, electrical engineer; W. Ward, 275, Bowling Old Lane, Bradford, electrical engineer; H. Fox, 47, Southfield Square, Bradford, electrical engineer; W. Wray, 36, Horton Lane, Bradford, traveller; R. Smith, 71, Haycliffe Hill Road, Bradford, engineer; F. Wall, 51, Union Street West, Oldham, electrician. The number of directors is not to exceed five; qualification, 100 shares. Messrs. J. A. Jessop and C. Wray are to be the managing directors. Registered office, Soho Works, Thornton Street, Bradford.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Telegraph Manufacturing Company, Limited (23,482).—Out of a nominal capital of £50,000, in £10 shares, says the last annual return of this company, 3,290 shares have been taken up, of which 646 have been issued as fully paid. The full amounts have been called and paid on the remaining 2,644 shares.

Callender's Bitumen Telegraph and Waterproof Company, Limited (16,682).—This company's yearly return, filed on June 11th last, shows that out of a nominal capital of £80,000, in £10 shares, 6,316 shares have been taken up. The full amount has been called and paid on 3,316 of these, and £30,000 has been agreed to be considered as paid on 3,000 shares.

Cambridge University and Town Electric Lighting Company, Limited (29,244).—On May 10th last Mr. Arthur Barrett, of Cambridge, wrote to the Registrar of Joint Stock Companies to the effect that the above company have never made any allotment, or commenced to carry on business.

Cuttriss, Wallis & Co., Limited (33,857).—This company's yearly return, filed on the 22nd June, shows that out of a nominal capital of £10,000, in £5 shares, 771 shares have been taken up. The full amount has been called on 351 shares; £1,755 has been received, and £2,100 has been agreed to be considered as paid on 420 shares.

Corlett Electrical Engineering Company, Limited (36,200).—This company's yearly return has recently been filed. It shows that out of a nominal capital of £10,000 in £10 shares, 620 shares have been taken up. The full amount has been called and paid on 520 shares (£5,200), and £1,000 has been agreed to be considered as paid.

Hobart Electric Tramway Company, Limited (35,926).—The last yearly return of this company shows that, out of a nominal capital of £105,000, in £1 shares, 45,000 shares have been taken up, and that £20,000 has been agreed to be considered as paid on 20,000 shares. The full amount has been paid on 25,000 shares.

International Electric Subway Company, Limited (35,209).—The yearly return of this company, lately filed, shows that out of a nominal capital of £25,000, in £1 shares, 21,857 shares have been taken up, 20,000 of which have been issued as fully paid. The full amounts have been called on the remaining 1,857 shares; £1,850 has been paid, and £7 is outstanding.

Australasian Incandescent Gas Light Company, Limited (38,399).—This company filed its yearly return on the 13th ult. It shows that out of a nominal capital of £35,000 in £1 shares, 20,007 shares have been taken up. The full amount has been called and paid on seven shares, and the remaining £20,000 has been agreed to be considered as paid.

Cube Sugar Company, Limited (39,766).—This company's statutory return shows that out of a nominal capital of £18,000 in £1 shares, 12,807 shares have been taken up, and that the full amount has been called on seven shares. Nothing has been paid, but £12,800 has been agreed to be considered as paid.

Calthrop Brothers, Limited (40,083).—This company's statutory return shows that out of a nominal capital of £10,000 in £10 shares, only seven shares have been taken up. The full amount (£70) has been called and paid on these.

BUSINESS NOTICES, &c.

Personal.—Miss Bailey, who has been chief operator at the Birmingham establishment of the National Telephone Company for 14 years, was last week presented by her colleagues with an address and a gift of silver plate on the occasion of her marriage.

Mr. Ed. C. De Segundo's offices are now to be found on the third floor of 28, Victoria Street, he having been obliged to move from the ground floor in order to secure a larger suite of offices in the same building.

A few personal friends of Mr. J. Rance, jun., presented him on Monday with a pair of binocular glasses and pocket compass prior to his departure to the Transvaal for Messrs. Johnson and Phillips to erect a transmission of power plant for the Sheba Gold Mining Company.

Mr. A. Grundy, late manager and director of Baily and Grundy (London) Limited, has been appointed electrical engineer to the Battersea Polytechnic Institute.

Electric Lighting in Tasmania.—The Launceston Gas Company has offered to withdraw its opposition to the proposed central electric lighting station in Launceston, provided the City Council will fix a minimum rate for electric lighting.

Tenders for Electric Lighting Public Hall and Library, Canning Town.—The following is a complete list of tenders sent in:—

Contractors.	General lighting.	Extra power for blowing organ.	Extra for footlights on stage.	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1. Fanshawe & Grant.	839 0 0	60 0 0	18 0 0	917 0 0
2. Henry F. Joel & Co.	896 0 0	114 16 0	45 0 0	1,055 16 0
*3. Brush Electrical Engineering Co. ...	916 0 0	144 0 0	15 0 0	1,075 0 0
4. Wenham & Waters	1,060 0 0	117 5 0	53 0 0	1,230 5 0
5. Fowler, Lancaster and Co.	1,073 0 0	85 0 0	38 0 0	1,196 0 0
6. Raynes, Smith & Co.	1,089 15 0	...	37 17 6	1,127 12 6
7. Harry South ...	1,110 0 0	(approx.) 75 0 0 (including footlights)	30 0 0	1,215 0 0
8. W. Mackie ...	1,130 0 0	244 0 0	...	1,374 0 0
9. Fenton & Barnes .	1,150 0 0	60 0 0	15 0 0	1,225 0 0
10. Laing, Wharton & Down	1,183 0 0	172 0 0 gas engine £73	15 0 0	1,370 0 0
11. Verity & Sons ...	1,189 0 0	123 0 0	28 0 0	1,340 0 0
12. Rowland, Barnett and Co.	1,200 0 0	100 1 6	45 0 0	1,345 1 6
13. Suter & Co. ...	1,219 0 0	30 0 0	12 10 0	1,261 10 0
14. Paterson & Cooper	1,232 0 0	...	25 0 0	1,257 0 0
15. Statter & Co., Ltd.	1,264 0 0	75 0 0	210 0 0	1,549 0 0
16. Strode & Co. ...	1,267 0 0	187 0 0	33 0 0	1,487 0 0
17. Crompton & Co. ...	1,298 0 0	220 0 0	66 0 0	1,584 0 0
18. British Electric Light Co.... ...	1,323 0 0	110 0 0	15 0 0	1,448 0 0
19. Roger Dawson, Ltd.	1,339 0 0	...	30 0 0	1,369 0 0
20. Vaughan & Brown	1,340 0 0	66 0 0	23 0 0	1,429 0 0
21. C. A. Hemmingway	1,350 0 0	...	...	1,350 0 0
22. Holmes & Co. ...	1,375 0 0	136 10 0	25 0 0	1,536 10 0
23. Peter Jones ...	1,376 7 9	30 0 0	17 1 0	1,423 8 9
24. J. C. Howell, Ltd.	1,378 0 0	...	61 0 0	1,439 0 0
25. Stone & Co. ...	1,384 0 0	146 10 0	31 0 0	1,561 10 0
26. R. A. Scott, Ltd. ...	1,398 0 0	85 10 0	25 0 0	1,508 10 0
27. Thames Ironworks Company	1,440 0 0	79 0 0	18 0 0	1,537 0 0
	1,600 0 0	79 0 0	18 0 0	1,697 0 0
	1,950 0 0	79 0 0	18 0 0	2,047 0 0
28. Leonard G. Tate ...	1,410 0 0	90 0 6	35 0 0	1,535 0 0
29. Parr & Gillies ...	1,457 0 0	104 0 0	15 0 0	1,576 0 0
30. Lund Bros. & Co.	1,466 0 0	70 0 0	15 0 0	1,551 0 0
31. Brown & Co. ...	1,500 0 0	75 0 0	25 0 0	1,600 0 0
32. New & Mayne ...	1,500 0 0	200 0 0	25 0 0	1,725 0 0
33. Hill, Percival & Co.	1,511 0 0	75 0 0	25 0 0	1,611 0 0
34. Hulett & Co., Ltd.	1,515 0 0	251 0 0	13 0 0	1,779 0 0
35. Marryatt & Lilly-white	1,525 0 0	140 0 0	44 0 0	1,709 0 0
36. Edmundsons, Ltd.	1,559 0 0	90 0 0	25 0 0	1,674 0 0
37. R. Phipps & Co. ...	1,585 0 0	275 0 0	28 0 0	1,888 0 0
38. John C. Christie ...	1,668 0 0	...	...	1,668 0 0
39. Douglas C. Bate ...	1,688 0 0	91 0 0	45 0 0	1,824 0 0
40. Benham & Sons ...	1,753 0 0	105 0 0	18 0 0	1,876 0 0
41. Binks & Co. ...	1,877 10 0	150 0 0	45 0 0	2,072 10 0

* Accepted.

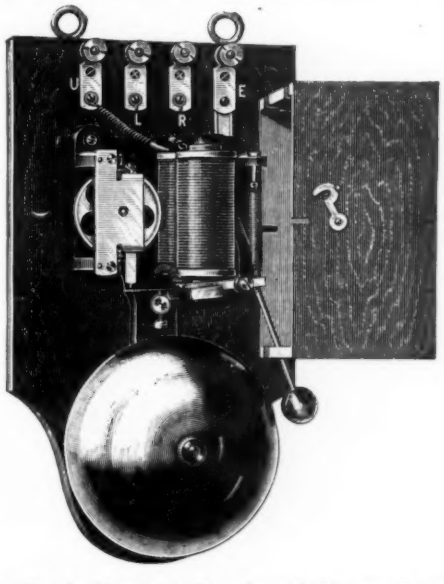
Xntric Switches.—Mr. H. T. Paiste, of Philadelphia, whose well-known switches have for years past been largely used, not only in America but also in Great Britain and other countries, has recently brought out a new series to which he has given the name of "Xntric." The name suggests the principle upon which the switch works. When the handle is turned, an eccentric on the handle shaft pulls the eccentric strap inward until its outer end is free from a stop that is attached to the base. The spring which, during the operation has been wound up, instantly throws the eccentric strap and its attached contact plate to the next stop, of which there are four. We understand that these switches have taken very well in America and will very shortly be put on the English market.

Factory Lighting.—Messrs. Bennett & Druce, of Preston, have secured the order for an installation of electric light through the Crosse Hall Mill of Mr. J. H. Gillett, of Chorley. The plant consists of a 12-kilowatt dynamo driven off the main mill engine, and about 200 incandescents distributed over the spinning department. The firm is exceedingly busy with various installations in progress in the Lancashire district.

Electric Lighting in Afghanistan.—The Ameer of Afghanistan having decided to introduce electric lighting into Cabul, Mr. R. Jamieson Brown, electrician to the British India Steam Navigation Company, has gone to the capital for the purpose of superintending the erection of an installation. Mr. Brown, who was the assistant electrician at the Glasgow Exhibition in 1888, received his training in the firm of Messrs. Muir & Mavor, Glasgow.

Traction on Common Roads.—The first prizes in the competition organised by the *Petit Journal* for horseless carriages fell to vehicles worked by petroleum and gazoline. Other prizes were awarded to steam propelled carriages. Electricity was, unfortunately, not represented at the contest, an electrical vehicle which was designed to run being confiscated by the Custom House authorities.

Improvement in Electric Bells.—In offices, hotels, or even in private houses, the shrill tone of an ordinary electric trembling bell is sometimes the cause of irritation, and in order to obviate this disadvantage, a slow striking bell has been brought out which is not only of service where less noise is desirable, but answers the purpose of a two or three-way indicator. As will be seen from the illustration, the bell works with rack and pinion, thus ensuring a reliable contact pressure, while the consumption of current is restricted to the very



short duration of such contact. It can be used either as a slow striking bell, as a single stroke bell, or as an ordinary trembling bell, according as the four terminals are connected up. The bells are made by the International Electric Company, London.

The New Post Office Buildings.—The large new building designed for the Administrative Department of the Post Office is nearly finished, and it is to be hoped the transfer will be made before the new year. The Postmaster-General, the Secretary, the Clearing House, the telegraph accounts, the solicitors and the telegraph message branches will be located in this new building. The electricians of the Post Office are now engaged in fitting the whole building for the electric light.

Messrs. Rashleigh Phipps & Co.—Messrs. Rashleigh Phipps & Co. are lighting Mr. W. D. Mackenzie's town house, 35, Park Street. This firm has also received instructions to light the house of Mr. Anderson Critchett (the celebrated oculist) in Harley Street. They are also engaged upon a large number of other installations in London and country.

The Lighting of Dunoon Castle Gardens.—The electric light has been introduced with great success into Dunoon Castle Gardens. Messrs. Walter Dixon & Co., St. Vincent Street, Glasgow, carried out the work.

Lighting of Luton.—The Town Council are going to oppose the application of the Municipal Electric Lighting Corporation for a provisional order.

Stores Lighting.—A very large installation has just been completed at the Huddersfield Industrial Society's stores; there are 48 arcs and 270 16-C.P. incandescent lamps.

Library Lighting. The contract for the temporary lighting of the Blackburn Free Library has been given to Messrs. Briscoe & Shaw.

Printing Machines and Electricity.—The printing machines of the *Oxford Times* are driven by electric motors, current being obtained from the public mains.

Tunbridge Wells Station.—The tender of Messrs. Longley & Co., of Crawley, for the central station building at the sum of £2,789 has been accepted.

Street Lighting at Newcastle.—We hear that the Newcastle Corporation are endeavouring to make arrangements with the local companies for lighting the streets throughout the town.

Warehouse Lighting.—The Warehouse Committee of the Mersey Dock Board recommend that the Albert Warehouses be lighted by electricity.

The Day Supply at Hampstead.—After consideration the vestry have decided to charge 4d. per unit for day supply.

Yarmouth Lighting.—Work is progressing satisfactorily, many of the street lamps being already in position.

Tottenham Lighting.—The Tottenham Local Board are considering the advisability of lighting Tottenham by electricity.

Hammersmith Lighting.—The Vestry have decided to apply for a provisional order.

City and Guilds of London Institute.—The Council of the City and Guilds of London Institute have conferred the Fellowship of the Institute upon Dr. W. E. Sumpner, who was awarded the Diploma of Associate of the Institute in 1887, and has since by many original and valuable researches contributed to the advancement of the electrical industry. The Council have also conferred the Diploma of Associate upon the following matriculated students who have this year successfully completed the full course of instruction at the Central Technical College:—Civil and Mechanical Engineering: Abbott, N., Aldis, B. S., Bushell, C. L., Carter, R. B., Cautley, A. O., Hall, A. C., Hallett, A., James, J. H., Lightfoot, C., Lloyd, H. G., Maeers, F., Stubbs, B. T., Thomas, W. Applied Physics and Electrical Engineering: Abrahamson, M. A., Bowden, J. R. J., Day, P. J. C., Fullerton, R. A., Harris, A. F., Leake, H. C., Mayes, A. E., Mentheth, W. F. S., O'Gorman, M. J. P., Robinson, L. L., Severs, J., Taylor, A. K., Ward, J. A. W., Wood, R. J. C. Applied Chemistry: Crighton, A. M., Marshall, A, Schwabe, E. W. S.

Electricity versus Gas.—New & Mayne, of Palace Chambers, Westminster, have secured the contract for lighting the streets of Woking with incandescent lamps. The first instalment will consist of 48 single light posts and 13 two light posts. Each lamp will be of 25 candle-power. This firm also successfully illuminated the Town Hall, Kingston-on-Thames, by electricity on the occasion of the annual boro' regatta held on 25th inst. The whole of the outline of the façade of the building was picked out in incandescent lamps with a royal crown in the centre, and below a transparency showing the arms of the corporation. A search light was also operated from the summit of one of the towers. The illumination was repeated on Saturday evening at the request of several members of the corporation.

The Northern Society of Electrical Engineers.—A party consisting of members of this society returned this week from a most enjoyable and instructive excursion to the Antwerp Exhibition. Through the courtesy of the directors, members visited the Rue du Chantier station of the "Compagnie Hydro-Electrique Anversoise," and some of the members who visited Brussels had the good fortune to see through the central station in that City.

Middle Temple.—The Benchers of the Middle Temple have decided to light their ancient hall, Parliament Chambers and Library Buildings by electricity, and the scheme prepared by Messrs. Massey and Allpress, consulting engineers, of 25, Queen Anne's Gate, Westminster, has been entrusted to Messrs. Strode & Co., who will carry out the work during the coming long vacation.

Transmission of Power in South Africa.—We mentioned some time ago that Messrs. Siemens & Halske had suggested a scheme for the transmission of power from Brakpan along the Witwatersrand. Permission has now been granted by the Government.

The Bath Electric Light Company.—The local papers speak of the accession of new customers to the Bath Company's system. Numerous premises are being wired, and we understand that firms are preferring the electric light to the Welsbach gas burners.

The Electric Mains at Chelmsford.—The wires are now being placed underground. A second agreement has been made by the town authorities with the company for a further term of five years.

The Hampstead Engineer.—Mr. R. A. Chattock, late superintendent engineer at the Amberley Road Station of the Metropolitan Company has been appointed chief electrical engineer to the vestry.

Electric Lighting at Geelong, Australia.—The Crompton Electricity Supply Company, of Sydney, N.S.W., has made an offer to establish a complete plant for the public street lighting of Geelong and suburbs by electricity for the sum of £15,150.

Winchester Electric Lighting.—Last week members of the Winchester Corporation proceeded to Bournemouth, to witness the electric lighting experiments which we referred to recently.

Belfast Lighting.—Although the works are not yet complete, the municipal authority are receiving applications outside the compulsory area.

Embezzlement.—George Wilson, lately a clerk in the employ of the Electrical Accessories Company, has been sent to prison for six months for embezzlement from his employers.

The Hampstead Scale of Charges.—In the Hampstead scale of charges published in our last issue, 3·7d. per unit should be 5·7d. per unit.

CONTRACTS OPEN AND CLOSED.

OPEN.

Melbourne.—The City Council is inviting tenders until September 11th next, for the supply and delivery of 500,000 arc lamp carbons. Tenders are to be sent to the Town Clerk, Melbourne.

St. Pancras.—The Vestry are prepared to receive tenders for the supply and laying of armoured cable mains. Further particulars will be found in an advertisement.

CLOSED.

Canning Town.—Lighting Public Hall and Library.—As will be seen from our "Business Notes," the tender of the Brush Company for £1,075 has been accepted.

CITY NOTES.

United River Plate Telephone Company, Limited.

The report of the directors states that at par of exchange the gross receipts for the year were £134,076 15s. 10d., the working expenses in the River Plate £60,874 0s. 3d., and the loss on exchange £54,124 17s. 9d.; leaving a profit, after the deduction of debenture interest and all other London charges, of £9,782 4s. 4d. It is proposed to write off £500 against bad and doubtful debts, £500 against the Mendoza Land, £270 premium on the balance of the 7 per cent. debenture bonds paid off, and to transfer to depreciation and renewal fund, £3,000, leaving a net balance of £5,512 4s. 4d. This sum, increased by £905 13s. 0d. (the balance brought forward from last year's account), amounts to £6,417 17s. 4d., which has been carried forward. The capital outlay for the year was £3,038 5s. 8d., as against £3,394 10s. 9d. for the previous year. The plant has been maintained in good and efficient condition at the cost of revenue. Notwithstanding the considerable and unexpected rise in the gold premium, the business of the company has steadily improved during the year. The directors feel confident that the shareholders, in view of the continued uncertainty in the affairs of the River Plate, will approve of the action of the board in carrying forward a substantial balance to strengthen the financial position of the company.

Chili Telephone Company, Limited.

The fifth ordinary general meeting of this company was held at Winchester House, E.C., on Tuesday morning, when Mr. T. Greenwood, the chairman presided over a small attendance of shareholders, and was supported by the Hon. F. Ernest Allsopp.

The Secretary (Mr. Edmund Petley) presented the report and accounts, already published by us.

In moving the reception and adoption of this report and accounts, the Chairman said: It will probably be more convenient and agreeable to you if—the report and accounts having been for some time in your hands—we take them as read, and should any shareholder desire any information respecting them I shall be glad to answer any questions to the best of my knowledge. You will probably expect me to say a few words explanatory of the position and prospects of the company. There can be no doubt the year we have just passed has been the worst the company has seen, and I think and hope I may fairly add the worst the company is likely to see. There are three things required for the complete success of the undertaking. The first is doubtful, the second is probable, and the third, being beyond the control of the board, cannot be estimated. The first applies to working expenses. The aim of the Board from the outset, and in this they have been supported by the managers both on the other side and at home, has been, by every reasonable means, to reduce the expenses. But unfortunately every movement in this direction has been made void and practically cancelled by the reduction in the value of the dollar. Thus it has come to pass that, simultaneously with our endeavours to reduce expenditure, expenses which are imperative have grown through the loss of money in the exchange as between ourselves and those on the other side of the water. At the same time, it is not impossible that further reductions may be made. The Board has now before it a scheme propounded by the officers on the other side with the view of making a part of their remuneration dependent on the profits of the company—a very desirable thing to do in the circumstances, as having the effect of our paying less in bad times, and making better payments when the revenue will better bear them. The board highly appreciate that suggestion, and I think the shareholders will be ready to acknowledge with us the generous and considerate spirit which has marked the conduct of gentlemen on the other side. The second point to which I have referred is the probable increase in our receipts. The board have waited patiently and long hoping to see a rise take place in the exchange, but it has gone down lower and lower, year after year, until it has touched the very low figure of 10½d. for the dollar. In these circumstances the board felt the absolute necessity of an increase of rates, but they were anxious not to resort to the course if it could possibly be avoided. I am pleased to say that while our instructions to increase were on their way, the manager on the other side had already taken the same view as ourselves, and had issued a circular precisely to the same effect as our instructions, showing that our ideas were the same. Whilst I think it probable the number of subscribers may, as a consequence, diminish, yet I have no doubt an increased traffic may fairly be expected. During the three months since March 31st, our receipts have increased every month from our subscribers, advancing from $1,153 in April to $2,600 in May, and $5,555 to the 3rd of June, notwithstanding a small reduction in the number of subscribers, and for a larger income we have done somewhat less work. The third head on which I desire to say a few words is the rate of exchange, and that is perhaps the most unpromising and unfavourable part of our outlook. I hold in my hand a diagram

which has been sent over by our general manager on the other side, comprising 47 columns, representing the months during which the company has been in existence. This shows in a very complete and comprehensive manner that the receipts of the company have gradually risen from $225,337 to $505,866. On the other hand, the rate of exchange shows that the dollar has depreciated in value from 26d. when we commenced operations, to, at the date of this diagram, 13d., or exactly one-half. That in itself is a complete commentary on our financial position, and explains our having gone so long without a dividend. At the same time, I think there is a fair prospect of improvement. You may ask me the ground for that belief, and no doubt the knowing gentlemen connected with financial affairs having proved themselves wrong, it is difficult for anybody to speak with much confidence on the subject. The latest reports, however, seem to me to show the government of Chili to be in a much better position than it was, and that whilst the amount of sterling money they have in hand for the redemption of the currency amounts to some millions, the new Congress, which began business on the 1st of June, comprises a large amount of talent and a determination to work together for the common good of the nation rather than in a partisan spirit. Should present apparent promises be fulfilled within the next two years, I think we shall see the dollar at 24d. again, and the prospects of the company accordingly improved. An alteration, indeed, in any one of the three things to which I have referred would make a material difference in the aspect of our affairs, and lead not only to a dividend, but a dividend in cash. I beg to move the reception and adoption of this report and accounts.

The Hon. F. Ernest Allsopp: I beg to second that.

If there are no questions to be asked, may I declare the report carried?—I do declare it carried unanimously.

The Chairman: We have one other duty to perform, namely, to elect an auditor in the place of Mr. Thos. Welcome, who offers himself for re-election.

Mr. Dey accordingly proposed and Mr. Bonner seconded the re-election, and on being put to the meeting, it was carried *nem. con.* the remuneration to be the same as hitherto.

The Chairman announced with regret the retirement from the board of Colonel Jackson, who, at the time, was seriously ill, but was now gradually improving, and was about to seek a change in a more bracing atmosphere. The Colonel had good commercial knowledge, excellent business capacity, and his acquaintance with telephone matters made his presence an acquisition to the board. He trusted to see him amongst them again, should his health be restored.

Thanks to the Chairman, proposed by Mr. Henderson and seconded by Mr. Baillie, concluded the proceedings.

The Globe Telegraph and Trust Company, Limited.

The twenty-first ordinary general meeting of this company was held on Friday at Winchester House, Old Broad Street, Sir John Pender, M.P., chairman of the company, presiding.

The report and balance-sheet were taken as read.

In moving the adoption of the report of the directors, the Chairman said: Before I ask you to approve of the report, I will, as usual, go over some of the details of the last year's working and give you such information as I can which will be of interest to you. The receipts for the year, after paying all expenses, amount to £185,076, as against £188,931 for the year ending 1892-3, which shows, I am sorry to say, a decrease of £3,874. From this amount there has been distributed the sum of £125,955 in interim dividends, leaving an available balance, as shown by the report, of £60,425. The object of the Globe Telegraph and Trust Company has been, and still is, to invest your money to the best advantage, having, to a large extent, the future of the various companies invested in in view, and to equalise the profits made in the whole, so as to be able to pay our own shareholders a fair interest at the end of each year. This object has been, to a very large extent, attained during the present year, and you will see that although we have had smaller returns, we have yet been able to pay dividends for the year of 6 per cent. upon the preference and 4½ per cent. upon the ordinary shares, and carry forward a balance of £527—the final dividend which your directors recommend being 3s. per share on the preference and 3s. 9d. per share on the ordinary shares. As I have said the object of the Globe Trust Company is to equalise dividends paid by the various telegraph companies in which they are interested as investors, and that object has been attained, because, although we have a smaller return from the Anglo-American Telegraph Company, the Telegraph Construction and Maintenance Company has given us a larger return than we had from them last year. The decrease in our receipts for the year is not a large one, whilst our dividends are above the average, and we are able to show a return of £5 5s. per cent, and we are able to recommend a dividend of 4½ per cent., against 4⅝ per cent. last year. This reduction in a time of great depression cannot be regarded as large, and, as I have said, the dividend we are paying is still above the average, for taking the preference and ordinary shares together the return is £5 5s. per cent. The depression to which I have referred not only affects this country, but every country in the world, and I think we have to congratulate ourselves that we are not in a worse position than we are—our profits only having depreciated ¼th per cent., which by no means is a large depreciation on our capital. The Anglo-American Telegraph Company has paid us £4,200 less than last year, and the Direct United States Cable Company has paid us £900 less, but this has been satisfactorily explained. In the case of the Anglo-American Company, the return per cent. on our company's investment is £2 10s. 8d., and in the case of the Direct United States Cable Company the return is £5 5s. 5d. per cent. The Submarine Cables Trust is paying us a little less than usual, £4 19s. 9d. instead of 6 per cent. The Telegraph Construction and Maintenance Company last year paid us 15 per cent. instead of the usual 20 per cent., and you will probably remember that at the last annual meeting I did not hold out much hope that this company would return to its high rate for some time; but this year the company has (and I think wisely) reverted to the 20 per cent. dividend, and I only hope that this will continue, and the rate per cent. which we receive on our investment in this company is £6 13s. per annum. In the Direct Spanish Telegraph Company we have acquired 346 shares during the current year, bringing up our holding to 998 fully paid £5 shares, representing £4,990, and on this investment our return of interest is small—£3 5s. 7d.—but the difficulty we have been in is to know where and how to invest money profitably. The banks only allow 1 per cent. interest, and investments in consols are not profitable. We have invested some money temporarily in Egyptian 3 per cents, which, of course, will not run away from us, and we shall keep it there until something turns up more in accordance with what meets our views as desirable investments. Our investments in the other companies are practically the same as last year, and most of, if not all of our investments are good ones. The West African Telegraph Company is not paying a dividend this year, but next year I hope to be able to make a better report, as the company has decided to send out a small repairing vessel. The West Coast of America Telegraph Company has not paid any dividend this year, but there is now a connection with Lima, and all the connections are shown to be in working order. Only the other night we received a message from Lima and returned an answer in the short space of 2 minutes 40 seconds, an achievement never before equalled. And this shows that if good work will bring traffic that traffic will come to the West Coast of America Company, and we may therefore hope that we shall by and bye get something on our investments in this company. Of the £62,000 6 per cent. debentures of the Direct Spanish which were paid off on May 1st £16,989 has been invested in the Western Union Telegraph, the American Cable, Submarine Cables Trust, and in ordinary and preference shares in the Direct Spanish, and the remainder is practically awaiting opportunities for good and sound investments. Before concluding these remarks, I may mention that although the capital of the company is about three and a half millions, held by some 9,000 shareholders, the work of the office is done at a very low figure. The work of the office has greatly increased of late years, and is still increasing, for there are constant transfers of shares, and large holdings are being split up into small holdings which adds to the number of shareholders. We have only a small staff to do the work, and there is a great deal of work to attend to, and yet the whole of the work is done at the rate of 2s. 6d. or ⅛th per cent. on the capital, and I do not think you can very easily beat that. The paid up capital of the company is £3,602,690, the present value of which is £3,920,536, the surplus being £317,846, or more than £20,000 better than this time last year. I allude to this in order to bring to your notice the extraordinary statements which some person took the trouble to circulate in November last in reference to the position of this company. That person issued a circular, under an anonymous name, in which he called attention to the "fact" that this company was in a state of bankruptcy. To that circular we replied and showed by quoting figures that we were not in a state of bankruptcy, but that on the contrary we were in a flourishing condition, and if that gentleman needs to be further convinced I hope that the statement of fact which I have just made, viz., that there is a surplus on the paid up share capital of £317,846, will convince him. I cannot help thinking that the gentleman who wrote the circular was very ignorant about our affairs at the time of writing, and I venture to think that he will think twice, or even thrice, before he makes any such statement in the future. For myself, gentlemen, I am satisfied that you will be pleased with the statement which I have made. To conclude what I have to say: All telegraph enterprises throughout the world are more or less influenced by the prevailing trade depression, and it is further influenced by rumours about laying down new cables. Some of these rumours may be realised; others will not. Doubtless, whatever the result, a thoroughly efficient system of telegraphy will be maintained for the convenience of the public, who will appreciate the increased facilities. But whatever may happen in the future I hope that the management of the concerns will be conducted with common sense, that they will not run into ruinous competitions, but will husband their resources and carry out to the best of their ability the trusts reposed in them by their respective shareholders. I beg to move the adoption of the report.

Lord Tweeddale seconded.

The report was carried *nem con.*

The retiring directors, Lord Sackville A. Cecil and Lord Tweeddale, were re-elected.

The auditors, Messrs. Deloitte, Dever Dever, Griffiths & Co., and Mr. Wm. Griffith, were re-elected.

In reply to a shareholder, the Chairman said that the circular to which he had referred, stating that the company was on the verge of bankruptcy, was signed "Scrutator." The gentleman had not the courage to give his name.

A cordial vote of thanks to the board of management, which was replied to by the chairman, brought the proceedings to a close.

Manchester Edison-Swan Company, Limited.

The twelfth ordinary general meeting of this company was held on Monday at the Memorial Hall, Albert Square, Mr. V. K. Armitage chairman of the company, presiding. The directors' report, which was taken as read, was as follows:—The net profit, including last year's balance, amounts to £1,508 17s. 5d., which it is proposed to appropriate as follows:—To writing off balance of loss on Williamson Electrical Engineering Company, £940 0s. 1d.; to special depreciation owing to change of showrooms, £256 5s. 6d.; to special depre-

ciation on stock of lamps on expiration of patents, and to reduction in value of cables, £306 11s. 5d.; balance to be carried forward, £6 0s. 5d. The directors view the result of the year's trading as satisfactory, considering the depressed state of trade during the last 12 months, and the fact that the company's monopoly of the lamp trade has now ceased. They propose to write off the whole of the loss made on the Williamson Electrical Engineering Company, Limited, and the special depreciation shown above this year, and accordingly do not recommend the payment of a dividend.

The Chairman, in moving the adoption of the report, referred to the work that has been undertaken at Altrincham and Bowdon, and said he thought that from that installation the shareholders were justified in expecting a satisfactory financial result. He believed that in that and in other directions the future of the company was hopeful.

Mr. F. B. Ross seconded the motion, which was adopted.

Mr. F. B. Ross and Mr. W. P. James Fawcus were re-elected directors.

A vote of thanks was accorded to the directors, and the sum of £150 was voted to them for their services during the past year.

The Anglo-American Telegraph Company, Limited.

The ordinary general half-yearly meeting of the above-named company was held at the Cannon Street Hotel on Friday last, the Marquis of Tweeddale (chairman of the company) presiding.

The notice convening the meeting having been read,

The Marquis of Tweeddale in moving the adoption of the report and balance-sheet said: I am sorry gentlemen to remind you of a fact which you will have already learnt for yourselves from the report that the traffic receipts for the half-year have been extremely disappointing, amounting only to £130,094, as against £146,885 in the corresponding half-year, showing a diminution of £16,791. Although this, of course, is very disappointing, I cannot suppose that the decrease in the receipts has surprised anyone having a knowledge of the state of commerce in this country and in the United States. So long as the tariff question in the United States remains unsettled there is but little or no prospect of any change for the better, but when that question is happily disposed of then I think we may fairly anticipate a substantial increase in our receipts. The total expenses of the half-year, including the repair of cables, &c, amounts to £55,716, or £4,465 less than this time last year. Happily the company's repairing steamship *Minia* has come to the rescue financially and has earned £4,050 more than in the corresponding period last year. The net result is that after placing £12,000 to reserve the board of directors are able to recommend a dividend on the ordinary stock for the second quarter of the half-year of 10s. per cent. and of £1 per cent. on the preferred stock, carrying forward £1,173, or £690 more than last year. I am happy to inform you that the 1874 cable has at last been repaired, and we have now four cables across the Atlantic, all of which are duplex. The fifth cable—the French cable—we have not attempted to repair this year, nor do I think there is any probability of that repair being undertaken this year. In restoring the 1874 cable (and I am happy to be able to add that the new cable was laid successfully, the last splice being made only a short time ago), serious inroads have been made into our reserve fund. The repairs amount to about £22,000, and this year they will cost about £20,000 more, so that the reserve fund will be reduced to about £530,000. The amount which we propose to set aside to reserve, viz., £12,000 each half-year, with the interest earned by the fund, is a minimum figure; but in view of the fact that the cables are in such good order, and that the company possesses a new cable, which may be considered, for a few years at least, as part of the reserve, we believe that we may go on with that small sum added to the fund every half-year for some time, at any rate, gentlemen, you have read with considerable interest that judgment has at last been given in our favour in the proceedings between our company and the Paris and New York Telegraph Company. That judgment, at any rate, proves that our contention was correct, and that the French company had committed a serious breach of their agreement; but whether the result of the decision will be attended with any great financial benefit to the "pool" companies is doubtful, for it is impossible to express an opinion as to what view will be taken by the experts by whom the damages are to be assessed. There is one part of the decision to which we strongly object, namely, that part which limits the period of damages from December 1886 to May 1891, and we are considering whether it would not be wise and proper to appeal against that part of the judgment. The opinion of the most eminent counsel in Paris is being taken on this matter, and on their opinion and recommendation will depend the action of the "pooling" companies. You will have heard, no doubt, with some dismay, of the probability—or rather of the possibility—of one or two other cables being laid across the Atlantic. One cable, it was said, was contemplated by French people, and another cable by the German Government. As I have before pointed out, the Atlantic is free to anyone to lay cables in. With regard to the intention of the French people, the board have no reliable information, but with regard to the German Government we believe it is their intention to grant a concession for a new cable from Germany to America. It is not surprising that the Government of Germany should desire to have greater facilities than they now possess; and therefore it is not surprising to hear that the Government should lay another cable to America, and so have a second means of communicating with the United States. I believe that this concession contains a subsidy or grant of money to the concessionaire, and I believe that a cable may be expected to be laid certainly not sooner than 1897—more probably 1900—so that there is considerable time before us before that cable can be laid. If a concession should e granted by the German Government, then you will doubtless agree with me that it is to be hoped that it will fall in the hands of friendly instead of hostile competitors; that is to say, in the hands of those who have large interests in the "pool" companies.

Mr. Francis A. Bevan (the deputy chairman) seconded the adoption of the report and balance-sheet.

The motion was carried *nem con.*

In reply to Mr. Goodsall, the Chairman said 220 miles of cable was used in repairing, and that the condition of the 1874 cable was in a very fair condition. The board would be in a better condition to answer questions when Captain Trott's report was received.

A vote of thanks to the chairman and board concluded the proceedings.

City and South London Railway Company.

Mr. Grey Mott presided at the meeting of the company held at Winchester House on Wednesday last. At the outset he referred to the increased number of passengers, amounting to 236,498 over that of the corresponding period of last year, and the increase in season ticket holders amounting to 49. This increased number of passengers had been carried with their usual perfect safety and almost absolute punctuality. They had got this increase in spite of the fact that during the first three months of the year the Oval was closed for football matches, which undoubtedly deprived them of a large amount of traffic. Looking at the whole result, however, it was a fairly satisfactory one. They had got the railway in all its details into thorough working order, and of late the directors had turned their attention to how far they could, in smaller details, improve the working, and making the railway more convenient and attractive to the passengers. With that view they had improved the station at King William Street. They had introduced cloak rooms at this station, which he considered would be of the greatest utility, not only to their own passengers, but also to the general public; to this they looked for some fair remuneration. They had also been improving their trains, and they had one now which ran easier, with less noise, and was brighter and better in every respect. As was mentioned in the report, they had been considering very carefully whether it would be possible to do away with the existing locomotives and to try motors on the carriages, an arrangement, by the way, which it was originally intended to use, but in deference to the Board of Trade they had adopted a separate locomotive. The arrangement of the motors on the carriages would give them room for an additional carriage. Unfortunately, they did not know whether it was possible to carry that out; experiments were being made, but the difficulties arising from the smallness of the tunnels and other matters, rendered it somewhat dubious whether the arrangement could be carried out. He hoped, however, for the success of the experiment. The chairman then dwelt upon some of the items in the accounts. They had paid off the £8,200 5 per cent. debentures, and reissued them at 4 per cent., and they had reduced the outstanding accounts to £1,410. They would see that the total working expenses were 61·7, as against 64·61 of last year. If they took away the cost of working lifts, the cost came out about 52 per cent., which was lower than that on many English railways. He hoped, however, to see these working expenses further reduced, but that would depend on the increase of traffic. The receipts per train-mile were the same as last year, though they had run an increased mileage. The locomotive expenses per train mile were 6·21d., against 6·48d.; 72,779 trains were run during the half-year. Although the dividend was not large, they were making steady, if not rapid, progress. He could not hold out any prospect of more rapid progress on the line as it now stood. Their appliances were very limited, and until some extension of line took place they must be content with a steady and slow movement upwards. They were doing their best to accelerate it, and doing all they could with the materials at hand. He concluded by moving the adoption of the report.

Two Shareholders criticised the accounts, their contention being that greater economies might be effected.

After a little further discussion, the report and accounts were adopted.

Liverpool Overhead Railway.—The report for the past half-year shows that, including £2,598 brought forward, the net profit amounted to £7,695. Interest on debentures and calls paid in advance required £2,639, leaving an available balance of £5,056. Dividends at the rate of 5 per cent. per annum on the preference shares and of 1 per cent. per annum on the ordinary shares are declared, which will leave £1,010 to be carried forward.

The Kensington and Knightsbridge Electric Lighting Company, Limited.—This company has declared an interim dividend at the rate of 5 per cent. per annum on the ordinary shares for the half-year ending June 30th, payable on and after August 2nd.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 29th, 1894, amounted to £858; week ending July 30th, 1893, £824; increase, £34; total receipts for half-year, 1894, £3,458; corresponding period, 1893, £3,433; increase, £25.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of July were £2,800; as compared with £2,933 in the corresponding month of last year.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 27th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,162.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, July 25th.	Closing Quotation. August 1st.	Business done during week ended August 1st, 1894. Highest	Lowest.
184,500/	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	101 —104	...	...
1,134,640/	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	37 — 40	37 — 40 xd	38	...
2,932,680/	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	71 — 73	70 — 72 xd	71¾	70
2,932,680/	Do. do. Defd.	Stock	...	...	...	6½ — 7	6½ — 7	6⅞	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	12 — 12½	12 — 12½	12 7/16	12¼
18,700/	Do. do. 5 % Bonds	100	...	...	...	101 —104	... — ... xd	...	...
75,000/	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1 — 2	1 — 2	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	139 —143	139 —143	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	2 % §	¼ — ¼	¼ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19½ — 20½	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼ — 9¾	9¼ — 9¾	9¾	...
30,000/	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	103 —106	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	8½ — 9½	8 — 9 xd	8¾	8 7/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	15⅝ — 15⅞	15½ — 15¾	15⅝	15½
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16¼ — 16¼	16 — 16½xd	16 1/16	16⅛
105,900/	Do. 5 % Debs., repay. August, 1899	100	...	...	...	108 —111	105 —109	...	...
1,294,100/	Do. 4 % Mort. Deb.	Stock	...	...	...	115 —118	116 —119	116⅜	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅝ — 15⅞	15⅝ — 15⅞	15¾	15⅝
62,700/	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800/	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	116 —119	114 —117 xd	...	...
95,100/	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100/	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000/	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	105 —108	103 —106 xd	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5½% §	4⅞% §	4⅝% §	8¼ — 8½	8⅜ — 8⅝	8½	8⅝
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15½ — 15½	15⅝ — 15⅝	15⅝	15⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗ §	8⅗ §	8⅗%	20¼ — 20¾	20 — 20½	...	...
200,000/	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	44 — 46	44 — 46	45½	44¼
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000/	Do. do. 6 % Debs.	100	...	...	...	108 —111	108 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½ — 1½	½ — 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅞ — 5⅛	4¾ — 5	4 15/16	4 13/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½ — 15½	14 — 15	14¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	13½ — 14½	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½ — 5⅝	5⅝ — 5⅝	5½	5⅝
925,017/	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	109 —112	109 —112	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	⅛ — ⅝	⅛ — ⅝	⅛	...
100,000/	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	101 —104	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5 — 6	4½ — 5½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	110 —115	108 —113	110	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,370/	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	85 — 95	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900/	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	102 —105	103	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½ — 3	2½ — 3	...	...
150,000/	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	96 —101	96 —101	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	5 %	6½ — 7½	6¾ — 7½	...	...
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5⅞ — 6¼	5⅞ — 6¼	6	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1¾ — 2¼	1¾ — 2¼	...	...
178,200/	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	108 —111	105 —108xd	...	...
222,700/	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	108 —111	105 —108xd	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1½	1 — 1½	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10 — 10½	10 — 10½	...	...
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	...	...
80,000/	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110	107 —110	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
169,000/	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½ — 5⅛	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½ — 13	12½ — 13½	13⅛	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14 — 14½	14 — 14½	14 1/16	14¼
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	128 —130	128 —130	...	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½%	5 %	5 %	6⅝ — 6½	6½ — 6⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	8½ — 9	8½ — 9	8¾	...
100,000/	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	109 — 112	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7 — 7½	7 — 7½xd	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½ — 9	8½ — 8⅝	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6¼ — 6⅝	6 — 6¼xd	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, July 25th.	Closing Quotation, August 1st.	Business done during week ended August 1st, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅜ — 3	2⅜ — 3	3	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2½	2¼ — 2½	2 7/16	2¼
125,000£	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	110 —113	...	...
630,000£	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38	36 — 38	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	2½ — 3	2½ — 3	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — ⅝	½ — ⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1¼	1 — 1¼	1	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	¾ — 1	¾ — 1	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6 — 6½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	7 — 8	7 — 8	7½	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23⅝	23
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 3/16 — 8 5/16	8¼ — 8½	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12⅞ — 13½	12⅞ — 13⅛	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2⅛ — 2⅜	... — ...	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42	40 — 42 xd	41¼	40
150,000£	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	102—105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	... ...	2 — 2¼	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅞—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5½—5¾.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅞.

Liverpool Electric Supply, £5 (fully paid), 6½—6⅞.

Do. do. £3 10s. paid, 4½—4⅞.

London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

THE RELATION OF THE DRAWING OFFICE TO THE SHOP IN MANUFACTURING.*

By A. W. ROBINSON.

THE purpose of this paper is to describe the system employed by the writer in the drawing office of his company in the hope that some of the points may be of use to members of the society.

The drawing office is the origin of thought and action for the entire works as far as the design and construction of its product are concerned. It is responsible for the accuracy of its drawings and orders, and its authority should be unquestioned and above reproach in the shop. The shopmen should habitually trust and adhere to their drawings, and their faith should not prove to be misplaced. To maintain this there must be unceasing care and vigilance on the part of the office, and full adaptation to the shop needs and capabilities. It goes without saying that every drawing office, whether employing one draughtsman or a hundred, should have its system and methods adapted to the needs of the establishment with which it is connected. As these needs vary with each case, it is not to be supposed that the system about to be described will be of universal application. It will be well then to state in a general way the conditions which this system is intended to meet. We will assume, therefore, that the office employs from ten to fifteen skilled draughtsmen, and is in connection with a manufacturing establishment, doing a general engineering business in which there is comparatively little duplication of orders, and in which single orders frequently involve a large amount of detail, of which it is essential to keep exact records. It is also assumed that the drawing office is invested with the sole right and authority to issue orders to the shop for all new work, or all work in which there are changes and variations from previous similar work.

The practice of issuing verbal orders or directions for the conduct of work is productive of misunderstanding and confusion. When no evidence of authority exists no responsibility can be fixed. It is, therefore, advisable to have a system of written orders to all departments whereby the duty of those concerned is clearly defined, and the responsibility can be fixed for dereliction of duty.

* Paper presented at the Montreal meeting (June, 1894) of the American Society of Mechanical Engineers, and forming part of Volume XV. of the *Transactions*.

Shop Orders.—An order being once entered on the books of the company, the procedure is as follows: The business office issues a written order to both the drawing office and the shop upon a blank which merely states the general name of the machine, the time of delivery promised, and the number of specifications to be worked to if any, and the number by which the order is to be known. It is the duty of the drawing office to prepare such specifications beforehand when necessary. On the receipt of these orders in the shop, if it be a repair or duplicate of something already made, so that the shop superintendent has the information by which to execute it, he does so. If, however, it is new, or in any sense special work, he cannot proceed until the orders come down from the drawing office.

The drawing office issues orders upon the pattern shop and foundry by means of blanks headed "foundry" or "pattern shop," as the case may be, arranged thus:

B. S. S. & D. CO. ENGINEERING DEPARTMENT.

FOUNDRY ORDER.

Order No.	Date. 189	Draughtsman.
Countersigned by		Examined by

These are manifolded in triplicate, and can be made out by any draughtsman to whom the job is delegated, but must be signed by the chief engineer, or in his absence, the chief draughtsman. The two copies are then sent down to the shop superintendent's office, who keeps one on file for his own reference and information, and immediately sends the other to the foreman of the department for which it is intended. In this way the shop superintendent retains control of his men in the different departments, and has knowledge of the orders that are issued. He alone is responsible for their proper execution, and

undue interference of the draughtsman with the foremen or workmen is obviated.

It is also the duty of the drawing office to order all raw material for new and special work, that is not regularly kept in stock. This is done by blank as follows:—

B. S. S. & D. CO. ENGINEERING DEPARTMENT.

Date.	Please order the following
189	for Order No.

Ship

Draughtsman

Countersigned,

Chief Engineer.

These are simply requisitions on the business office, and the copy goes to the storekeeper as a statement that the articles noted have been this day ordered. He will therefore be expecting them, and on their receipt will at once know for what order they are intended. His copy of the manifold reads "The following material has this day been ordered for order No. —.

Written orders are not issued from the drawing office to any other departments, except the pattern shop and foundry. Drawings and sketch sheets are issued to the other departments, as machine, smith, and erecting shops, &c. These pass through the hands of the shop superintendent, and in themselves constitute an order to make what they represent or call for, provided they are covered by the original general order from the business office and bear the same order number.

By means of these written orders to each department, each foreman knows definitely what work he has on hand, and all responsibility for errors or delinquencies is at once traceable to the culprit.

The shop superintendent is also empowered to issue written orders to his foremen in all departments, for all work which does not require information from or the authority of the drawing office. For these he uses his own blanks—those of the drawing office being labelled "Engineering Department."

It frequently happens that on large orders involving much detail, it is desirable to push the construction of parts as fast as they are determined upon before the completion of the general design. In these days of urgency and high pressure this is almost a necessary evil, but should be pursued with caution in the drawing office, lest difficulty be found in fitting the later part of the design to the earlier. Under this system of written orders the parts can be ordered in as fast as they are ready, even though the shop superintendent is as yet uninformed as to the balance of it, and does not know of what the complete order is to consist.

When the drawing office work on the order is completed an order list is made out and typewritten in duplicate. The order list enumerates in detail all the items making up the complete order, and is divided up into headings such as (1) castings, (2) forgings, (3) miscellaneous, (4) special material ordered outside, and so on. For each item is given a reference number of the drawing or sketch sheet on which it is shown, and it is or should be shown thereon so fully and definitely that no further questions need be asked. This order list is essential: 1st, to inform the shop definitely of what the work consists; 2nd, to refer the shop to a source of information concerning each and every item; 3rd, to form a shipping list so that in shipment nothing will be overlooked that should be sent; 4th, to form a permanent record by which repairs may be readily identified, and from which future machines may be compiled or adapted. These order lists are press copied in a book for the purpose.

Drawings.—The primary function of a shop drawing is to answer the shopman's questions, and indeed it may be said that this is its only function. There are certain things connected with the material, form, dimensions, finishing, fitting and erecting of a machine and each part of it that each department needs to know. Sometimes, in simple cases, the various processes of pattern-making, finishing and erecting can be defined on one drawing, and in other cases separate drawings containing separate information for the different processes are demanded. It is important to have all the necessary information conveyed on a drawing in a direct and legible manner, and that the views be so chosen as to represent the object in the simplest way. Let the draughtsman, on beginning to make a shop drawing, say to himself, "Now what does the fellow who is to make this want to know," and then let him put down just that information and no more, but be sure and get it all on. Refrain from all superfluous lines and marks, and make the drawings so plain that "he who runs may read them."

The mere ability to make lines and circles and projections is really the least important and least valuable part of a draughtsman's skill. Neatness and accuracy of drawing is desirable, but if it is obtained with the expenditure of an undue amount of time, and does not carry with it a practical knowledge of shop needs and shop processes, it ceases to be a virtue.

The following set of rules for the drawing office have been found to be useful and to work well. They contain some points that a good draughtsman ought to know, but they are incorporated as reminders, and as being necessary to preserve uniformity of practice among changing draughtsmen.

Drawing Office Rules.

Shop Drawings.

1. All drawings shall be of the uniform size of 23″ × 36″.

2. All detail drawings for use in the shop shall consist of whole standard sheets, half standard sheets and sketch sheets. Half sheets shall be 18″ × 23″, formed by ruling a line across the centre of standard size sheets as filed, the blue prints only to be cut, and mounted and varnished, when necessary.

3. The sketch sheets shall be 8″ × 11″, and shall be used for all simple details, forgings, for bolt lists, and for all temporary work capable of being shown in this way. All standard machines shall be fully drawn out and blue printed. The sketch sheets shall be made with indelible pencil or copying ink and press copied in the book for the purpose. The information on the sketch sheets shall be as complete as that specified for drawings.

Character of Shop Drawings.

4. A shop drawing is to be considered as an order or instructions to the shop, and not merely as a statement or illustration. For this purpose it must convey clearly all the information needed to make and finish the article.

5. Every dimension necessary to the execution of the work is to be clearly stated by figures on the drawing, so that no measurement need be taken in the shop by scale. All measurements to be given with reference to the base or starting point from which the work should be laid out. In comparatively simple constructions the several parts are to be shown together complete, although each part must be figured independently, and details supplied, if necessary, by sketch sheet. In more complicated forms each part should be detailed by itself and a general drawing made showing the thing complete. No details should be sent out without putting them together on a drawing, or taking them from a general drawing, so as to insure their fitness. Unnecessary duplication of views to be avoided, except in display or advertising drawings.

6. All figured dimensions on drawings to be plain, round vertical figures not less than $\frac{1}{8}$th inch high, and formed by a line of uniform width and sufficiently heavy to insure printing well. No thin, sloping, or doubtful figures or diagonal-barred fractions will be tolerated. All figured dimensions below 3 feet to be expressed in inches.

7. All centre lines to be alternate dot and dash in fine black line. All dimension lines to be in continuous red lines, with a central space for the figure, and of such strength as to show on blue print more faintly than lines of drawing. Lines of drawing to be bold and clearly defined in proportion to the scale, and to be shade-lined by making the right-hand and bottom lines heavier. No ornamental shading or other "frills" allowed on shop drawings.

Title.

8. Every drawing, whether whole or half-sheet, shall have the title, date, scale, and number of the sheet placed in lower right-hand corner. One man will be detailed for this duty, to secure uniformity.

9. The name of the drawing, as given in the title, is invariably to consist of two divisions in one line separated by a hyphen. The first division is to state the general name of the thing or machine, and the second division is to clearly designate the part or parts represented (or if a general view, should so state). The wording of the titles should be submitted to the chief engineer or head draughtsman for approval.

Drawing Symbols.

10. Detail shop drawings should state:

(1). The pattern number of every casting in plain figures of larger size than the dimension figures.

(2). The number of each piece required for one set. This should be written in one word (not figures) and followed by symbol of material.

(3). The material of which the parts so ordered are made, using symbols as follows:

C.I.—Cast iron.	Bs.—Brass.
W.I.—Wrought iron.	Bz.—Bronze.
C.S.—Cast steel.	Bbt.—Babbitt.
M.S.—Machinery steel.	V.F.—Vulcanised fibre.
H.S.—Hammered steel.	C.R.S.—Cold rolled steel.

Other materials write full name.

(4). The kind of finish on each of the different parts will be indicated by a letter preceding the figured dimensions, as follows:

F.—Means "finish," and indicates that the surfaces to which it applies are to be machined or dressed in suitable manner to size stated.

F.B.—Means "finished bright," or polished.

G.F.—Means "grinding finish," and indicates that the only finish to be allowed is that necessary for grinding.

When no letter precedes the figured dimension it is understood that the part is to be left black or rough. In cases where finish might be presumed but not required, follow the figured dimension by the word "cast" if a casting, and "rough" if a forging.

(5). A reference list of sketch sheets may be used for detail illustrations.

Sketch Books.

11. Each draughtsman will be supplied with a sketch book by the company, and in which he shall make all his notes, calculations and data referring to his work, and under no circumstances shall original work be done on loose sheets and transcribed into these books. No effort should be made at neatness or nicety in these books, but each entry should invariably be commenced with the name of the thing and the date, and full notes made of data on which the calculations were based, and the results obtained clearly stated. These books are to be the property of the company.

Index for Drawings.

12. An index book for drawings will be kept in the drawing office by the clerk. This book will be divided into as many divisions as there are drawers, with provision for indexing 100 drawings in each drawer. The names of drawings will be added to the various divisions according to their classification. The system of numbering shall be as follows:

13. Each drawer shall be numbered consecutively, and shall contain drawings devoted to a certain class of work, which shall be indicated on the drawer label. The drawing number shall consist of two or more digits with a decimal point between them. The whole number shall indicate the number of the drawer, and the figures after the decimal point shall indicate the serial number of the drawing in that drawer. For example: drawing No. 5.16 is the 16th sheet in drawer No. 5, and drawing No. 75.96 is the 96th sheet in drawer No. 75. Not more than 99 drawings shall be put in one drawer, except in exceptional cases.

14. Sketch sheets will bear the number of the letter and page of the letter book, preceded by the letter S, to distinguish them from drawings, and will be indexed in their own impression book, but not in the drawing index book. They will be referred to on general drawing of which they are details, and will also bear the number of such drawing.

15. When making a new drawing the draughtsman will apply to the clerk for a number, and will be allotted the first unappropriated number in the division to which the drawing will belong.

16. On completion of every drawing or sketch sheet it must be examined and initialed by the engineer before being issued, and the following entries made in books kept for the purpose:

(A) Record of blue prints and sketch sheets issued to shop, giving date, number, and title.

(B) Drawing index.—Record in daybook the number, title, and sub-title, draughtsman and date.

(C) Pattern index.—Record in daybook the number, classification and correct name of patterns, with remarks and date.

Each draughtsman will see that these entries are properly made.

Patterns.

17. All patterns shall be numbered with the number of the drawing from which they are first made, followed by a letter indicating its serial on that drawing. For example, if four patterns are shown in detail on drawing No. 36.50, the patterns shall be numbered 36.50A, 36.50B, 36.50C, 36.50D. When existing patterns are utilised in a new design or machine, their original number is to be noted on the drawing on which they are shown in their new employment.

18. Upon receiving formal notice from the pattern shop that patterns are ready for inspection, the draughtsman connected with the order shall examine same and issue foundry order for the casting. The date of inspection and name of inspector shall be entered upon the pattern maker's report at the time of making such inspection.

The sketch sheets referred to in these rules are 8 × 11 inches in size. They are of stiff cardboard, and the heading is printed in copying ink. The sketch is made with an aniline copying pencil, the "Eagle No. 2" in wood being used. They are press-copied in books for the purpose, and several books are used for different classifications of work. The books are of slightly heavier tissue paper than is commonly used for correspondence, and have 500 leaves each, numbered consecutively throughout the series, so that the number of a sketch sheet is never duplicated. In this system there are six books for copying sketch sheets, representing as many classes of work, and these divisions will readily suggest themselves as required for any particular case.

The use of these sketch sheets is especially for work which does not require to be often duplicated, and for giving quick dispatch to emergency work. A free-hand sketch can be made, copied, and issued in this way in ten minutes, while the regular process of drawing, tracing, blue printing, and waiting for the latter to dry, or the sun to shine, may consume hours. They have the additional advantage of being more convenient to handle and file away in the shop than blue prints, and they save multiplication of tracings and consequent drawer space. The copies being in book form cannot be lost and are easily indexed and consulted. Sketch sheets are convenient for rapid detailing of forging and small parts, and such parts need, therefore, to be merely indicated on the general or erecting plan, and reference numbers given of the sketch sheets. The sketch sheets will also all appear as items in the order list.

In addition to the stiff card sketch sheet, it is convenient to have a "drawing office memorandum" blank. This is a copying-ink heading printed on a sheet of letter paper, and is used for order lists and all sketch matter sent abroad from the drawing office.

After copying, the sketch sheet, if for permanent use, is sized with a mucilage, composed of gum tragacanth and water, and then varnished with white shellac and alcohol. The sizing is to keep the lines of the sketch from running while varnishing.

Two necessary articles of office furniture are the drawing table and the blue-print frame. So many excellent forms of these have been devised that it seems hardly necessary to refer to them in this connection, but sometime hereafter occasion will be taken to describe types which have the merit of cheapness and effectiveness.

It is our practice not to finish original drawings, but to trace from them on tracing cloth. These tracings are used only to print from and are filed away in a fire-proof vault. Two prints are made of each tracing as soon as finished, one for the shop (or more if necessary) and one to file away in the drawers of the office. These drawers are 24 inches × 38 inches × 2 inches, and are each calculated to hold a maximum of 100 prints. In this way the tracings are preserved from risk of fire and loss, and from the wear of frequent handling.

As a rule each draughtsman makes his own tracings, and only skilled draughtsmen are employed. The writer does not advocate the employment of cheap draughtsmen to trace shop drawings from the originals of the designer. If this is done the designer must finish his original to entire completeness before turning it over to the tracer, thus consuming additional time and running more risk of errors and omissions than if he traced it himself. A skilful draughtsman will merely block out his entire work on the original and give his whole thought to the perfection of his design. In the tracing he can re-arrange his drawing if necessary, and the time occupied in tracing is usually much less than that employed in working out and perfecting the design, and a draughtsman, worth $120 per month, will usually trace twice as fast as one worth $60, and do it better.

The titles on drawings are mainly done by rubber stamps giving the name of the company, the number of the drawing, and having spaces for the insertion of name, date, and scale.

Some experimenting was done to find a suitable stamp ink for tracing cloth. Printers' ink was tried, but it rubs off and does not dry satisfactorily. A special lithographic ink is used, which is similar to printers' ink, but with the addition of a dryer. It is applied to the stamp by a composition roller in similar manner to printers' ink and gives a black impression which blue prints well. The number stamp has movable type.

As a rule it pays to employ only high-class labour in the drawing office. A draughtsman puts his own impress on his work, his individuality goes into it, even if closely supervised, and it is upon the perfection of detail that the success or failure of a new design mainly depends; it is important that the draughtsman entrusted with it shall have the necessary skill and ability.

We have appliances for testing the efficiency of almost every known mechanism, but who can measure the efficiency of a draughtsman. We appreciate the economic value of good steam distribution and the like, but too often is the efficiency of the draughtsman neglected, and thousands of dollars spent in the construction of work which would have yielded much better results if a little more brains had been used in its design.

In conclusion, the writer would say: Do not have so much system that it is difficult to work to or burdensome to carry out. A few simple rules, faithfully adhered to, are better than the most elaborate system which is loosely or imperfectly carried out. The object of a system is to define the duties of each man, and to fix the responsibility of dereliction of duty.

PROCEEDINGS OF SOCIETIES.

Royal Society.

"On the Effect of Magnetisation upon the Dimensions of Iron Rings in Directions Perpendicular to the Magnetisation, and upon the Volume of the Rings." By Shelford Bidwell, M.A., LL.B., F.R.S. Received March 2nd, 1894.

A recent communication* to the Society contained an account of some experiments relating to the effects of magnetisation upon the dimensions of two iron rings, one of which was annealed, and the other hardened. The rings had the form of short cylinders about 6 cm. in diameter, 3 cm. in height, and 0·4 cm. in thickness. The experiments in question were concerned with the circumferential variations which took place along the lines of magnetisation; those to be here described deal with the concomitant variations in the height of the cylinders (width of the rings) transversely to the magnetisation. On the assumption that variations similar to the latter occur at the same time in the thickness of the metal, it is possible to deduce the changes in the volume of the ring which attend magnetisation.

Fig. 1, from a photograph, shows how the rings were prepared for

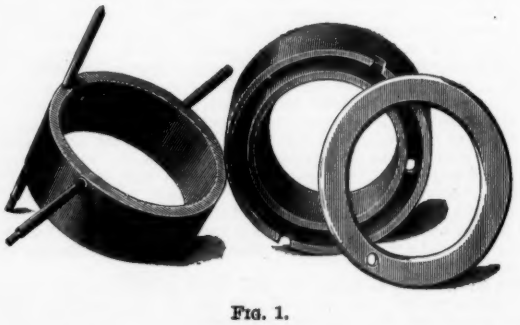


Fig. 1.

the experiments. Four brass rods were hard-soldered to the iron, two of them being in a line with a diameter, while the other two were attached to the edges, opposite to one another, and parallel to the axis of the ring. The ring was inserted in a wooden case, also shown, through holes in which the four brass rods projected. Insulated wire

* Royal Society *Proceedings*, Vol. 55, p. 228.

for carrying the magnetising current was wound over the wooden jacket.

For the new experiments the ring was placed in a horizontal position, one of the edge rods resting upon a brass socket on the adjustable base of the instrument, and the other, which had a chisel-shaped end, actuating the lever.* To counterbalance the weight of the ring a horizontal arm, carrying a sliding weight, was fixed to the lower rod.

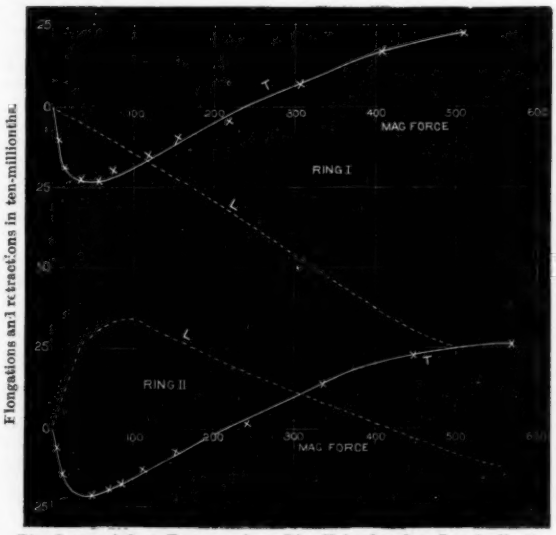
It need hardly be said that the experimental difficulties in the way of determining to a ten-millionth part the changes which took place in a length of less than 1½-inch were very considerable.

The annealed ring will, as before, be distinguished as Ring I., and the hardened one as Ring II.

Table I.

Ring I. (annealed).		Ring II. (hardened).	
Magnetising force, C.G.S. units.	Elongations in ten-millionths.	Magnetising force.	Elongations.
6	− 9	7	− 5
17	−18	18	−13·5
41	−23	47	−21
59	−21	69	−18
75	−17	82	−17
116	−13	117	−11
151	− 9	155	− 7
220	− 4	242	2·5
306	8	342	14
405	17	451	23
5·9	23	570	27

The changes observed in the widths of the two rings (transversely to the magnetisation) are indicated in Table I. and in the curves of fig. 2. It will be seen that they are quite similar in the two cases,



Ring I. annealed; T, Transversely. Ring II. hardened; L, Longitudinally.
The curves marked "longitudinally" relate to circumferential changes *along* the lines of magnetisation.
Those marked "transversely" relate to changes in the width, *perpendicularly* to the magnetisation.

Fig. 2.

little or no effect being produced by annealing. Under gradually ascending forces both rings first become narrower, and then recover their original width, and ultimately become wider than when unmagnetised.

The only previous experiments that I know of relating to magnetic changes of dimensions in directions perpendicular to the magnetisation are those of Joule†, who used a piece of iron gaspiping 1 yard long and ⅝ths inch in mean diameter, having an insulated wire inserted into it, and bent over the sides, so as form a magnetising coil of 1½ convolutions. The greatest current he used seems to have been about 12 ampères, and the magnetising force therefore about 8 C.G.S. units. With this he found a contraction in the length of the pipe of 7 ten-millionths, a result which agrees very well with that obtained by myself for the same small magnetising force.

As was shown in my last paper, the effects along the lines of magnetisation are very different in the two rings. The annealed ring (Ring I.) begins to contract circumferentially with the smallest forces, and continues to contract with the large ones; while the hardened ring expands with small forces and contracts with large ones. These effects are indicated in the figure by the dotted curves.

By combining the results of the old and of the new experiments, we can ascertain the nature of the changes produced by magnetisation in the volumes of the rings.

If k = elongation (+ or −) along the lines of magnetisation,
l = elongation (+ or −) transversely to the lines of magnetisation,
then the increment or decrement of volume when the ring is magnetised is approximately* $k + 2l$.

Table II.

Magnetising force, in C.G.S. units.	Increments and decrements of volume in ten-millionths.	
	Ring I (annealed).	Ring II. (hardened).
10	− 27	−11
20	− 42	−20
30	− 47	−20
40	− 51	−17
60	− 51	− 9
80	− 48	− 2
100	− 46	3
140	− 42	11
180	− 39	17
220	− 37	22
260	− 35	26
300	− 32·5	30
400	− 30	40
500	− 29	44

From the two sets of curves in fig. 1 corresponding values of k and l can be found, and thence the changes of volume may be deduced. These are given in Table II. and fig. 3, which show that the volume

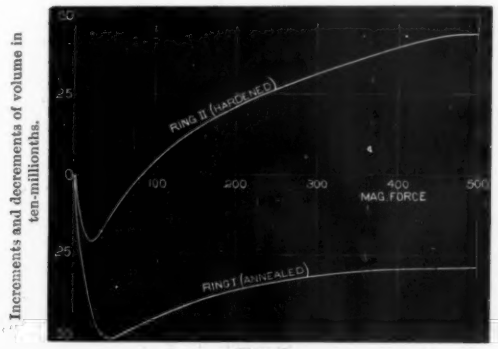


Fig. 3.

of the annealed ring is rather suddenly diminished by a small magnetising force, passes a minimum under a force of about 50 units, and then slowly increases, until, with a force of 500 units, it is about 30 ten-millionths less than at starting. The unannealed ring also at first suffers diminution, but its original volume is recovered with a force of about 90, and with high values is increased.

The behaviour of this latter ring may be regarded as probably similar to that of the great majority of rods and rings, the annealed ring used in these experiments being the only specimen of iron that has yet been found to contract along the lines of magnetisation with the smallest forces that produced any effect at all.

Experiments upon the volume changes produced by magnetisation have been previously made by Joule, Barrett and Knott.

Joule† concluded that the volume of an iron bar was altogether unaffected by magnetisation, even though the magnetising current which he employed "was quite equal to saturate the iron." It was at that time believed that "saturation" was produced by a force of from 80 to 100 units, and assuming that Joule's force was of about that value, an inspection of the curve for unannealed iron in fig. 3 will show the probable reason of his having failed to detect any change of volume. There is, in fact, none at all with a force of about 90 units.

Barrett,* experimenting in the same manner as Joule, "enclosing the bars in a vessel of water terminating in a capillary tube, and surrounding the vessel by a powerful magnetising helix," also obtained a negative result, perhaps for the same reason.

Knott's‡ experiments were made with hollow iron tubes, 45·7 cm. in length, 3·84 cm. in external diameter, and of different bores, ranging from 0·7 cm. to 3·19 cm. "Each tube was closed below, and into the upper end a nut screwed tightly, through a perforation in which issued a fine capillary glass tube. The nut was adjusted under water, so that the whole of the interior space of the metal tube was filled with liquid, and also part of the glass tube. When the tube was set vertically in the heart of the magnetising coil, the changes of volume were measured by the motions of the liquid meniscus in the capillary tube." "A few experiments were made on the external change of volume of a few of the tubes, which were enclosed in a thin-walled brass tube. The brass tube yielded because of its thinness, so that the results were not certain. But there was no doubt

* The chisel-shaped terminal piece was removable, and is not shown in fig. 1.

† Joule's "Scientific Papers," p. 236.

* *Nature*, Vol. 26, p. 485.

† Joule's "Scientific Papers," page 236.

‡ Edin. Roy. Soc. *Proc.*, 1891, p. 315; 1892, pp. 85, 249; Brit. Assoc. Rep., 1892, p. 659. The quotations are from the latter.

that with the specimens of iron tried there were large changes of volume."

The changes observed by Knott in the interior volume appear in the case of a tube of large bore to have been of the same nature as those in my unannealed ring; while with a tube of smaller bore they rather resembled the changes exhibited by the annealed ring. His published investigations are, however, only of a preliminary character, and it is not at present possible to make a satisfactory comparison between his results and my own. But he was undoubtedly the first to show that magnetisation is generally attended by considerable changes of volume.

NEW PATENTS—1894.

13,700. "Improvements in telephone switchboard mechanism." J. E. Kingsbury. (Communicated by the Western Electric Company, United States.) Dated July 16th.

13,706. "An improved shade for electric lighting and like purposes." A. H. Entwistle, H. J. Stephens, and A. Dubber. Dated July 16th.

13,710. "Improved means and apparatus for generating steam from refuse and the like, and storing heat." T. W. Baker. Dated July 16th.

13,728. "A combined pole and lamp post for supporting overhead wires or cables for electric tramways or railways, telegraph, telephone, and other wires or cables." A. Dickinson. Dated July 17th.

13,744. "Electro-magnetic massage roller." J. E. Spratt. Dated July 17th.

13,747. "An improved electrical coupling or terminal." W. H. Stevenson. Dated July 17th.

13,749. "Improvements in electric signalling apparatus." C. A. Allison. (Communicated by the Standard Electric Signal Company, United States.) Dated July 17th. (*Complete.*)

13,750. "Improvements in electric signalling apparatus." C. A. Allison. (Communicated by the Standard Electric Signal Company, United States.) Dated July 17th. (*Complete.*)

13,751. "Improvements in electric signalling apparatus." C. A. Allison. (Communicated by the Standard Electric Signal Company, United States.) Dated July 17th. (*Complete.*)

13,756. "Improvements in or connected with electrolytic cells and diaphragms therefor." C. N. Waite. Dated July 17th. (*Complete.*)

13,762. "Improvements in and relating to electric railways." C. D. Jenney. Dated July 17th. (*Complete.*)

13,765. "Improvements in and relating to electric railways." E. H. Johnson and R. Lundell. Dated July 17th. (*Complete.*)

13,771. "Improvements in and relating to electric railways." E. Lachmann. Dated July 17th.

13,791. "Improvements in or appertaining to incandescent electric lamps." W. L. W. Williams and G. H. Morgan. Dated July 17th.

13,794. "Improvements in electric conduits and conductors therefor." J. W. Eisenhuth, R. Herman, and E. M. Herman. Dated July 17th. (*Complete.*)

13,795. "Improvements in the process of electro-plating and apparatus therefor." W. P. Thompson. (Communicated by C. M. Barber, United States.) Dated July 17th. (*Complete.*)

13,836. "Improvements in apparatus employed in the evolution and collection of hydrogen and oxygen gases by electrolysis." C. J. Yarnold. Dated July 18th.

13,871. "Improvements in or relating to electrical transformers or converters." J. A. Kelman. (Communicated by J. A. Kelman, jun., United States.) Dated July 18th.

13,995. "Improvements in or relating to electric railways." W. P. Thompson. (Communicated by J. F. McLaughlin, United States.) Dated July 20th. (*Complete.*)

14,029. "Improvements in prepayment mechanism application to gas, electricity, and like meters." S. Simpson. Dated July 21st.

14,065. "Improved electric fuse head for use in blasting." W. A. Malson, T. Malson, S. R. Malson, and E. Smith. Dated July 21st.

14,080. "Improvements in incandescent electric lamps." G. F. Redfern. (Communicated by C. Schwabe, Germany.) Dated July 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

7,711. "Improvements in electrical accumulators or secondary batteries." P. Schoop. Dated April 15th. According to one arrangement of secondary battery with insoluble electrodes, according to the invention, each separate secondary element consists of a vessel of glass, ebonite, or other similar insulating material, with vertical positive and negative electrode plates, placed at equal distances apart, the negative plates being made to fit tightly against the sides of the vessel but not to touch the bottom, while the positive plates fit tight both against the sides and the bottom. By this means the liquid electrolyte entering the cell at one end is obliged to flow in a vertical serpentine direction successively over the surfaces of all the plates from the one end to the other. 3 claims.

10,042. "Improvements in and apparatus for the manufacture of plates, grids, or supports, for secondary batteries." F. King. Dated May 19th. The inventor effects the economical, efficient, and rapid production of the plates, grids, or supports, by rolling them from the metal (usually lead) from which they are formed, which rolling is effected in such a manner that the plates, grids, or supports, leave the rolls, or the last of a series of rolls, in a complete and separate form. 3 claims.

10,130. "Improvements in means for supplying current for driving vehicles on electric railways or tramways." H. Pieper, jun. Dated May 20th. Relates to means for conducting the electric current to the motors on the vehicles of electric railways, in which brushes or collectors arranged underneath the vehicles rub against contact pieces, consisting in short rails or plates arranged at regular intervals along the track, and forming branches from an underground main or feeding conductor, each contact piece being connected with the said main by automatic apparatus acting only when the vehicle comes with its collector upon or over the contact piece, and being again disconnected when the collector leaves the latter, so that the said contact pieces are electrically connected with the distant generator or source of current only at the time when they are touched by the collector attached to the vehicle, the contact pieces in advance of and behind the collector being all disconnected. 5 claims.

10,134. "Improvements in the construction of armatures for dynamo-electric machines. W. B. Sayers, H. A. Mavor, W. A. Coulson, and S. Mavor. Dated May 20th. The several coils which constitute the armature winding, and which may be made of equal length and resistance, are wound in the form of long loops arranged around the armature core, within or upon which one side of each of them is secured. A suitable clamp or holding device is then applied to the other side of each coil, and the armature core, with the portions of the coils secured thereto, is then rotated relatively to the portions of the coils held by the holding device until these portions of the coils are brought opposite to the required portions of the armature core, to or within which they are then secured in any suitable manner. 3 claims.

10,142. "Improvements in and relating to electric generators, motors, and transformers." W. Fritsche. Dated May 20th. The armature of this improved machine is characterised by the fact that the armature core, differing from the constructions heretofore employed, is divided perpendicularly to the direction of motion, so that strips are produced with intermediate spaces which serve for the reception of the armature winding. 3 claims.

10,648. "An improved combined electric light and heat stove." G. Mitchell. Dated May 31st. Claims:—1. The application of a liquid medium to absorb and convey heat produced by an incandescent or other electric lamp when yielding light to suitable radiators, substantially as described and illustrated in the drawing. 2. The construction and combination of parts for the purposes set forth, and described and illustrated in the drawing.

11,122. "Improvements in secondary batteries or accumulators." A. E. Peyrusson. (Under International Convention.) Dated April 1st. Claims:—1. In an accumulator whereof the positive electrode is constructed of vertical, horizontal or other metallic laminæ soldered to a central metallic core, the application of end discs of lead retaining said laminæ in combination with capping discs of insulating material adapted to prevent all contact between the two electrodes, as specified. 2. In an accumulator, the positive electrode constructed of thin metallic perforated discs threaded on and soldered to a central metallic core, as specified. 3. In an accumulator, the negative electrode constructed of longitudinally corrugated metallic plates rolled in the form of a hollow cylinder, each ply being slitted for a portion of its length, the said plates being inserted in and soldered to end rings of pure or antimoniated lead, as specified. 4. In an accumulator, the combination of a positive electrode of lamellar construction, and provided with end discs of lead and capping discs of insulating material, as specified in Claim 1, with a negative electrode constructed of corrugated slitted plates rolled to cylindrical form, and soldered to end rings, as specified.

11,183. "An improvement in grapnels for submarine cables." W. C. Johnson. Dated June 7th. The prongs are jointed to the shank by pivots situated somewhat above the level of the points of the prongs, which, by means of springs, are caused to project beyond the edge of a conical shield, which encloses all the internal parts of the grapnel. 3 claims.

11,384. "Improved method of and apparatus for regulating the electromotive force of electric generators." J. S. Raworth. Dated June 9th. The inventor regulates the electromotive force of an electric generator or generators by acting upon the governor of the engine driving the said dynamo or its exciter, or of each such engine, when more than one are used by means of an electro-magnet or solenoid of sufficient strength to control the speed of the engine to the required extent. 2 claims.

12,142. "A safety switch for electrical lock and block apparatus on railways." E. Tyer. Dated June 20th. Relates to a safety switch arranged in any conducting line for electrically operating lock and block apparatus in such a manner that, when an operator gives or unlocks a signal, or moves or unlocks a set of points, or performs any other operation which leads to the blocking of part of a line by the admission to it of a train or of a truck or carriage, he at the same time breaks a contact and thereby renders farther electric operations impossible until the train or the trucks or carriages have passed a treadle or other appliance on the line, by the action of which an electric current is made to operate the safety switch so as to restore the contact. 3 claims.